THE PSYCHOLOGY OF LEARNING

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AN EXPERIMENTAL INVESTIGATION OF THE ECONOMY AND TECHNIQUE OF MEMORY

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Translated from the Third Edition of "The Economy and Technique of Learning"

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PREFACE TO THE AMERICAN EDITION

I have gladly consented to the publication of this translation of my "Economy and Technique of Learning," because the monograph will be made accessible to a larger number of readers.

Experimental psychology and the most important field where it finds practical application,—that is, experimental pedagogy,—are based upon the product of the combined efforts of students of psychology and pedagogy in the United States and in Germany; it may indeed be said that these sciences have been created by the two nations. So firmly am I convinced of this community of interest and of endeavor that in all of my writing I constantly keep the American reader in mind. Much wider in scope than the "exchange of professors" between these two countries have been this continuous interchange of scientific ideas and this mutual inspiration which have been going on these many years.

In both countries, too, there is a deep-rooted conviction that the most important problems of the science of education can be solved only by an appeal to experimental psychology, and by an application of the methods of psychology to the problems of pedagogy.

The more then must one deplore the fact that until recently experimental psychology has devised no means by which the pupil's daily tasks of learning in all its various forms may be accomplished more readily. The efforts which had hitherto been made to facilitate the work of learning were limited either to the old, and harmful, custom of transforming the memorial material into verse and then memorizing the verse

mechanically, or to the employment of other mnemonic devices. But mnemonics admits of only a very limited application both in the affairs of daily life and in the work of the schoolroom; and since it burdens the memory with a mass of artificial auxiliary ideas, it really increases instead of diminishing the work of memory. Moreover, the discovery and employment of mnemonic aids demands a degree of ingenuity which is not possessed by every child.

The increased demands of the present age require children to master a much greater body of knowledge than was deemed necessary in former generations. This condition has given rise to the problem as to the best means of avoiding overburdening the pupil, which is an inevitable result of his increased tasks. This difficult problem can not be solved by eliminating important subjects from the curriculum; it can be solved only by devising improvements in methods of learning and in methods of teaching which shall be psychologically sound.

It is the aim of the present monograph to meet this urgent demand for methods of learning which shall be psychologically most appropriate, and which shall embrace all of the different kinds of learning. It begins with methodical observation as the basis of all memorial work. It seeks to develop rules for systematic observation. It discusses the most favorable subjective and objective conditions for mechanical memorization; and it endeavors to establish at least a few of the cardinal points for the retention of logical associations,—a process whose nature is still imperfectly known. Our present knowledge of the economy and technique of learning is still in need of being supplemented by practical instructions as to how best to master the various concrete tasks with which the pupil is daily concerned.

Such directions dealing with the retention of concrete

material, with the learning of foreign vocabularies, of names and dates, of poems and prose selections, I hope to publish in the near future; and it may be that that may also be made accessible to American readers.

I desire here to express my sincere thanks to Dr. Baird for undertaking the work of translating this monograph.

E. Meumann.

PREFACE TO THE THIRD GERMAN EDITION

The experimental investigation of memory has made substantial progress since the second edition of this book was published. The pioneer work of Ebbinghaus has been supplemented by several psychologists, who have hoped by this means to extend our knowledge of the general basis of memorial function and to discover its laws. Psychiatrists and pathologists have made an accurate study of pathological disturbances of memory, which furnish a new insight into the functioning of normal memory. Semon, Rignano and others have thrown a wholly new light upon the bodily correlates of memorial processes; and certain of the more recent summaries which cover the whole field of memory, such as those of Offner and Schoeneberger, have also contributed to the solution of our problems.

A new edition of this book must, therefore, consist in a complete working over and an extensive supplementation of the text of the first and second editions.

Important changes have been made in the first three chapters. The chief purpose which I have had in view in introducing the supplementations in the present edition was to meet the demands of a wider circle of readers. My readers have repeatedly expressed the desire that I should incorporate a brief summary of the fundamentals of the general psychology of memory. Accordingly, I have presented in the opening chapters an epitome of the essential features of the present psychology of memory; and lest the introductory chapters of the book should become too extended, the dis-

cussion of the researches in psychiatry, which was presented in detail in the second edition, has been condensed. As a result of this the book now approximates a psychology of memory; but, in order that the original purpose of the book should not be abandoned, the results of psychological experiments have, so far as possible, been considered throughout from the point of view of their significance for practical life and for the work of the school.

The fact that the first and second editions were exhausted within a few years shows that educators are recognizing, more and more, the importance of experimental psychology and pedagogy for the work of the schools. Numerous communications, inquiries, suggestions, and expressions of approval of the discussions of the first and second editions have come to me from teachers; and they have been so numerous that I could not, unfortunately, always reply as I should wish.

May the new edition win new friends for experimental psychology and pedagogy!

E. MEUMANN.

Hamburg.

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The experimental treatment of the problems of psychology and pedagogy has furnished the modern student with a wealth of information which remained unknown during the non-experimental stages of these sciences. And this knowledge proves to be of profound practical significance in directing the efforts of both the teacher and the pupil. Psychological and pedagogical experimentation has given us an insight into the complex conditions of mental activity; and we are beginning to lay a secure foundation for the technique and economy of mental work. The mental processes which constitute the basis of the school-work of pupils are opened up to exact analysis; a great part of the mental work of children which was formerly left to accidental success and to the instincts of the child can now be directed in a manner which is psychologically most appropriate. All of these are problems of which the older pedagogy had scarcely an inkling; and the pedagogy of the future will be enriched by a new sub-division of "method" because, in addition to methods of teaching, methods of learning must also be considered. Many of the investigations which are now being devoted to an analysis of the mental life of the child have not yet extended beyond the four walls of the psychological laboratory. Indeed, the subject-matter of the present volume is drawn from investigations in experimental pedagogy which are still far from being completed in all of their details; and

this circumstance may explain why many of our inferences bearing upon the work of the school-room are still hypothetical in character. The reader will find, however, that we have drawn a distinction throughout between statement of established fact and statement of mere conjecture.

The questions which will be discussed in this volume are concerned, in the first place, with the general principles of our modern doctrine of memory, and with the technique and economy of "mental noting,"—by which is meant the imprinting upon memory of any sort of material as a result of attentive perception and observation where no special effort to learn is present; next in order come the technique and economy of *verbatim* learning; then the economy of memory in general in school-children; the fundamental differences of memory-types among individuals; and, finally, a number of interesting miscellaneous results which have been obtained as a by-product of the experimental investigation of memory.

In the traditional pedagogy we read a great deal about methods of teaching; but, in most cases, the pedagogical text-books can tell us nothing about methods of learning. And yet we find ourselves confronted by the very serious question as to whether the efficiency of school-room management may not be increased by systematically improving the pupil's procedure in the act of learning in such a fashion that his learning may be perfected in its technical aspects and accomplished more economically. This question becomes the more pressing in modern times because our courses of study, in their attempt to comply with the increasing requirements of practical life, are becoming more and more exacting in the demands which they make upon the memory tasks of school-children.

In order to make this clear to the reader, we must first of all develop the meaning of the economy and technique of

learning. Ignoring for the present the fact that we may speak of learning or imprinting upon memory in very different senses, we find that in every kind of memorial acquisition of every sort of material, in practical life or in the school-room, the learner must always fulfil the following conditions:

1. In the act of learning, he must endeavor to proceed in the most suitable manner and in accordance with psychological conditions of learning, *i.e.*, he must fulfil those conditions of learning under which the particular, present purpose of his learning can best be attained. For instance, if the aim of his learning be, in one case, a literal memorization of a poem, in a second case, a permanent retention of a concrete material, and in yet a third case, the association of foreign words with their equivalents or synonyms in his own language, this diversity of purpose brings with it a diversity in the conditions of learning under which his goal can best be attained. We must attempt to investigate these conditions and to make the learner familiar with them.[1]

2. All the varieties of memorial acquisition have, however, certain characteristics in common because they are all memorial work in the broadest sense of that term; and all memorial work, in turn, is subject to certain general conditions and laws, which must be fulfilled if anything is to be imprinted permanently upon memory. These general conditions of all learning must also be investigated; and the learner must become familiar with them if he is to be able to fulfil them in his act of learning.

3. Every learner has his own peculiar individuality, and

[1] It is really self-evident but since other views of the matter are held it must be mentioned that upon the point of view of the purpose which the learner seeks to attain depend all other points of view concerning the economy of learning, even that of economy of time and of energy.

his own individual endowment; and in consequence of these the general conditions of learning and the means of attaining a special goal in learning are often modified to a considerable degree. From this it follows that individual variations in memorial work must be investigated; and each individual must be trained to employ his own procedure correctly.

4. Besides these general conditions of learning, and these individual conditions, and these conditions which depend upon the purpose which the learner has in view, we must consider certain artifices or artificial devices which may facilitate the act of learning. Every technique involves certain artifices or tricks of skill, certain artificial aids and modes of procedure by means of which an end may more readily be attained; and the technique of mental work is no exception to this general rule. It is a well-known fact that mnemonic devices are alleged to furnish an aid to memory. Hence it devolves upon a technique of learning to inquire into the psychological justification and the practical utility of artificial aids to memory; and rules which are at once psychologically sound and justified by the purpose in view must be formulated for the employment of such devices as aids to memorial work.

5. All of the foregoing refers to the technique of learning. But in addition to this we aspire to an economy of learning. It is the purpose of an economy of learning to enable the learner to secure a maximum result at a minimum cost of time and of energy, and consequently to enable him to accomplish his task with a minimum degree of fatigue and with a minimum danger of over-fatigue.

It may be said, in summary, that an economy and technique of learning endeavors to investigate not only the general mental conditions of learning but also those special mental conditions which depend upon the specific purpose

for which a particular act of learning may have been undertaken; it also endeavors to make these various conditions subject to the will of the learner. It attempts to specify the particular conditions which depend upon the peculiar mental constitution of the individual learner; it investigates the possibility of taking advantage of technical aids and artifices in learning, and of finding a psychological and a practical justification for employing them; it aims to give the learner instructions as to the best means of saving time and energy, and of attaining the highest degree of efficiency in remembering and reproducing what he has learned.[1] Our problem then may be said to deal with the question: What methods or modes of procedure in learning are based upon a sound psychological, technical and economical foundation?

There is always a parallel between the subjective aspect,—the economy and technique of the work of the pupil,—and the objective aspect,—the teacher's presentation of the material to be learned,—in so far as the pupil's procedure is determined by the teacher's mode of presentation. For instance, if at one time the pupil acquires a given material in a visual fashion, from seeing it, and at another time in an auditory fashion, from hearing it, his mode of acquisition has varied with the mode of presentation; it took its start from the written or printed text, in the former case, from the oral statement of the teacher, in the latter case. Hence in so far as these different external starting-points of the pupil's activity in learning constitute subjective conditions of his activity, we may also speak of an economy of presenting material to be learned.

It is evident that this way of looking at the matter consists simply in regarding the subjective conditions of learning from

[1] For a discussion of the various meanings of economy of learning the reader is referred to Appendix II.

the objective point of view, the mode of presentation. Yet there are certain practical reasons which justify a separate discussion of the influence of presentation upon learning.

It may also be noted that the experiments which deal with the presentation of material contain the first beginnings of a new branch of pedagogy, which may be called the economy and technique of teaching. And it may be that the psychology of memory will furnish the means of taking the first step toward an accurate experimental determination of rules and norms of teaching. In the discussions which are to follow, this possibility will frequently be indicated.

These general statements may be illustrated in detail by an observation of the memorial work of pupils. Even at an early age the pupil is called upon to accomplish a great variety of mental tasks; and we require of him a work of memory to which he brings but little, if any, experience. Now, mental work may be done by wholly different methods; the pupil's procedure may be exceedingly wasteful of time and energy, or it may consist in the formation of such associations as shall employ his mental energies in the most advantageous manner. For example, in memorizing a poem he may go through a slow and laborious process of adapting his attention to the subject-matter in question; or he may concentrate his attention intensively from the outset. His repetitions of the poem may be mechanical and barren of result; or he may make every repetition contribute its quota to the memorization of the material. He may make much or little use of the factor of rhythm; he may make much or little use of the meaning of the poem; he may pronounce the words audibly, semi-audibly or inaudibly; he may employ a rapid rate of pronunciation or a slow and emphatic pronunciation; he may divide the poem into small sections and memorize each section independently, or he may read the whole poem through

each time from beginning to end and memorize it as a unitary whole; he may learn it at a single sitting, or he may devote several sittings to the task, distributing the work over a longer period of time and introducing pauses between the several sittings; his learning may be of a purely successive sort, or he may employ in part successive and in part simultaneous and regressive associations.

Which of these methods of learning leads most readily and most rapidly to the goal,—to fluent and errorless reproduction? Which method secures the most permanent and the most accurate retention? Questions such as these arise in connection with every sort of memorial imprinting,—even with the imprinting of concrete sensory material, whether presented but once or presented repeatedly. Here again the learner may proceed in an unsystematic fashion with an extravagant expenditure of time and energy; or he may fulfil all of the conditions which are necessary for a systematic and effective imprinting of the material upon his consciousness. Thus in every department of memorial function we may speak of a technique and economy of memory; and that is the topic which we propose to evolve, in its essential features, in this volume. If we are to attain this end we must first discuss the foundation of the modern psychology of memory in order that, from this vantage ground, we may be able to throw light upon the various functions of memory, and upon the various sorts and cases of memorial activity for which we are to formulate specific, technical rules. Then we shall attempt to give the reader an insight into the experimental investigations which have, in recent times, established the conditions of the various sorts of memorial activity; and finally we shall discuss the more important results of these investigations, and indicate their significance for the work of the teacher.

THE PSYCHOLOGY OF LEARNING

CHAPTER I

A SURVEY OF THE MODERN PSYCHOLOGY OF MEMORY

In every-day speech, memory is understood to mean the capacity to imprint and to retain perceptions and ideas and, as it were, to incorporate them into consciousness as a temporary or permanent possession. That such an imprinting or incorporation has taken place, however, is revealed to us only by the fact that we can subsequently recall our experiences; but when the same impressions recur to consciousness we detect certain changes in our attitude and behavior,—a feeling of familiarity, a greater facility in re-learning, and the like. Strictly speaking then, we have an immediate knowledge only of the process of imprinting, on the one hand, and of the subsequent reproduction and the changed attitude on the other; everything that lies between these two termini completely escapes our direct knowledge. In so far then as we are limited to empirical observation, the sole manifestations of memory consist either in a reproduction or in a changed re-experiencing or in a modified re-learning of what has previously been experienced or learned.

Now since reproduction must necessarily depend, in some sense, upon a retention of impressions, and since our modified acquisition must be due to an after-effect of former contents of consciousness, memory may be briefly defined, for the present, as the capacity to retain perceptions or ideas and subsequently to revive them, or at least to experience after-

effects of their former presence in consciousness. And since it seems probable that an "after-effect" is only a species of reproduction, the present consequences of former memorial activity may all be referred to briefly as reproduction.

Educational psychology regards memory as a definite function and capacity which serves certain educative purposes. General or theoretical psychology, on the contrary, concerns itself, as a rule, not with mental capacities or functions but only with mental processes. The mental processes which are fundamental to memory are, on the one hand, the imprinting of impressions and the forming of associations among ideas, and on the other hand, the reproduction or revival or reappearance of ideas in consciousness; between these two processes lies the hidden intermediate member, the after-effect of former impressions or ideas, which is to be conceived as a latent survival of the dispositions and associations which were established by the original imprinting. It is important that association be distinguished from reproduction. Association is the initial formation of a connection between ideas which are present in consciousness simultaneously or in immediate succession, or which occur at least as links in a chain of ideas which constitutes some sort of a unitary whole for us. Reproduction, on the other hand, is the appearance of ideas in consciousness, or the entrance of ideas into consciousness,—a phenomenon which is rendered possible in most cases by a previously established association between these ideas and other ideas. In order to account for the imprinting and the subsequent reappearing of the idea, psychologists usually assume that every perception or idea which comes to consciousness, even if only once, leaves behind it a trace or after-effect. And since this residuum has to do with subsequent revival it is called a disposition to revival. The term disposition has a dual significance here. It indicates that the

idea tends to recur to consciousness through the aid of other ideas, or even in consequence of its own energy; but it also indicates that every revival of an idea is facilitated by impressions and by other ideas.

The doctrine of memory and of its origin in the association and reproduction of ideas has undergone a considerable change in modern psychology. The significance of memory has been essentially broadened and extended; and attempts have been made to distinguish memory more accurately from cognate mental processes.

The extension of the meaning of memory takes its origin from an endeavor, in itself perfectly justified, to bring the phenomenon as manifested by man, into relation with a group of related phenomena which occur elsewhere in nature. It has been hoped by this means to bring memory more nearly within the range of our comprehension, and especially to demonstrate the organic basis of memory dispositions. Thus the physiologists Hering, in 1860, and Hensen, in 1877, attempted to show that "memory is a universal property of organic matter." This view was extended by Haeckel, Forel and Mach, and more recently in a comprehensive volume by Richard Semon.[1] Semon calls the memory processes in general "mnemic" processes; and organic memory he calls mneme,—from the Greek μσήμη, memory. This extension of the meaning of memory receives its support from the fact that every process or activity which has once occurred in organized matter,—in nerve, in muscle, or even in simple cell or in groups of cells,—leaves behind it a disposition or after-effect as a result of which the same activity, on being repeated, is accomplished more easily and with a lesser expenditure of energy, and also in somewhat modified form. This survival of the dispositional after-effects of every activity is also the

[1] See Bibliography at the end of this volume.

basis of all of the effects which result from practice; and thus memory is brought into relation with all of the phenomena of practice. Now, it seems probable that the basis of all memory processes, in human as well as in animal consciousness, is to be sought in the physical phenomenon that former impressions and ideas,—or more strictly speaking, the physical parallels of these mental processes,—do leave behind them such a disposition to a more ready recurrence. There is no doubt that in this respect the human function of memory suggests characteristics which are common to all organic matter. But it is only to this rudimentary and general basis of memory in parallel bodily processes that we can apply this extended meaning of memory; and such a procedure does not help us in the slightest degree to understand the origin or nature of memory as a mental process. We must not lose sight of the fact that the survival of these enduring dispositions of impressions becomes comprehensible to us only when we assume that material modifications, of a temporary or permanent sort, take place in a substance which itself persists throughout; and that these modifications subsequently facilitate the recurrence of the activity to which they owe their existence.

Dispositions, in this sense of a permanent modification of an organ, do not exist in the domain of consciousness; nor can we speak, in any such sense, of mental or psychical dispositions. When a muscle or a group of muscles has made a particular movement a great many times, there ensues a muscular change which is continuously present as a persistent modification of the muscle-substance—a modification of its mass, of its structure, or of its chemical or molecular constitution. And these modifications constitute the basis of the muscle's subsequent capacity to accomplish the same activity in a more easy fashion. A somewhat analogous state of affairs

must be assumed for nerve-substance, and especially for the nerve-cells of the cerebral cortex, to which we ascribe those neural processes which run parallel with the processes of consciousness. But we find nothing in the domain of consciousness which is in any way a counter-part of this permanent modification of nerve-substance. So far as the phenomena of consciousness are concerned, we see only the results or the effects of the repetition of an activity or an impression,—for instance, we see simply the reproduction or the facilitated acquisition of the impression. We do not find any permanent modification of consciousness itself which can serve as a basis for this resultant of former activity. From this it follows, firstly, that we cannot speak of psychical dispositions in the same sense in which we speak of physical dispositions. Psychical dispositions must consist solely in the fact that mental processes run their course differently as a result of repeated recurrence. A second consequence is that, in so far as their bodily aspect is concerned, it becomes possible to explain the phenomena of practice,—and the processes of memory are phenomena of practice,—by referring them back to a more general physiological principle. So far as their mental aspect is concerned, on the contrary, such a tracing back of the processes of practice and memory to more general phenomena is impossible. They are rather to be regarded as ultimate facts; and we can only establish them as facts.

A second extension of the concept of memory is concerned with the mental aspect of memorial phenomena. This extension owes its origin to pathology and psychiatry (the investigation of the pathological conditions of mental life); it is interesting to note, however, that it was anticipated by the French philosopher Malebranche. It has been observed that all memory training has a twofold effect: a general or functional effect, which is to be regarded as essentially a phe-

nomenon of practice; and a special effect, which has to do with the content or material which is remembered. Kraepelin refers to this as a distinction between general memory and special memory.[1] Whenever we train the memory with any sort of material we bring about a twofold result: *1*. The material or content is imprinted upon our consciousness, and is thereby rendered capable of being subsequently reproduced; or in other words, by means of the activity of memory we acquire knowledge, a stock of particular ideas whose permanence of retention is proportionate to the thoroughness of their imprinting. *2*. But we also train the memory itself, *i. e.*, our general retentive and reproductive capacity is strengthened and improved by every act of memory. In this regard, also, the whole activity of memory appears as a phenomenon of practice, as it does in regard to memorial traces or dispositions. But our general capacity to retain and to reproduce also depends, in turn, upon the development of other functions of consciousness, especially upon the concentration and persistence of attention, the effort of will, the emotional condition and the like.[2]

Thus in training the memory we always develop all of these other formal capacities of mind as well; and hence in exercising the memory we derive an advantage not only in the direction of an acquisition of knowledge but also in the direction of an improvement of all of the general functions which are active in the work of memory and which make memory possible. It was this twofold function of memory which led to a distinction between general and special memory. This

[1] E. Kraepelin, Der psychologische Versuch in der Psychiatrie, *Psychologische Arbeiten*, I., 1894, 48.

[2] Cf. Ebert und Meumann, Ueber einige Grundfragen der Psychologie der Uebungsphänomene im Bereiche des Gedächtnisses, *Archiv f. d. gesamte Psychol.* IV., 1904, 208ff.

distinction, however, is by no means free from objection because the concept of a general memory is a sheer logical abstraction. As a matter of fact, we have no general memory, but only a number of special memories; and the term "general memory" has had its origin *a.* in the fact that every exercise of memory has this formal and general effect, that we develop it in all of its formal aspects, not only its capacity to acquire practice-dispositions in the domain of intellect, but also its capacity to set attention and will to work in the service of memory. *b.* But another fact has given rise to the concept of a general memory,—the fact that the training of each special memory is not confined to the special memory which is trained, but that all the other memories which are qualitatively similar or related to this special memory are trained as a result of its training.

The fact that related functions of memory are influenced by each other's training in proportion to the intimacy of their relation is our chief justification for speaking of phenomena of general practice in the domain of memory. The overlapping of training to related functions, however, is not a sufficient justification for assuming the existence of a general memory. In short, the concept of a general memory must, in my opinion, give place to the twofold concept *1.* that all memory training, besides its acquisition of content, also brings with it the cultivation of certain general functions which co-operate in all memorial acquisition; and *2.* that each member of a group of special memories which are related to one another shares in the profits which are derived from the training of any member of the group.[1] Of more importance than this extension of the meaning of memory are the attempts which have been made to define more accurately the nature of me-

[1] This latter phenomenon was pointed out by Ebert and Meumann, *Op. cit.* 200.

morial processes themselves. Modern psychology has modified the old view that memory consists in a retention and revival of ideas. It is not true that memory is simply a revival of old ideas, and that imagination differs from memory in that the former transforms ideas and re-combines them in novel and original forms. Every-day experience, no less than psychological investigation, shows us that memory also transforms ideas.

In the first place, our recollection of former experiences is invariably and necessarily of a more or less fragmentary character; and, in the second place, lacunæ in our remembrances are filled, in involuntary fashion, either by our customary associations rushing in and fusing with our fragmentary ideas, or by our function of judgment adding its quota to the remembered data. In this way, using parts of really remembered ideas, we build up a mosaic picture of the whole experience which we seem to remember. Rodenwaldt investigated the memories of a number of adults, employing as his material a picture of an infant in a cradle. The majority of his observers "remembered" that the color of the cradle was brown although it really was a conspicuous blue in the picture. Such falsifications of memory are products of the fusion of habitual associations. Since the wooden cradles which we ordinarily see are brown and not blue, the idea of the brown color comes in to supplement our memory of the picture of the cradle, and fuses with it if we have forgotten the real color. The second sort of transformation of our remembrances, which is a product of judgment, occurs especially in those cases where our perception turns out to have been of a fragmentary sort. In such cases we always endeavor by means of the function of judgment to eke out a picture of the complete details of the experience, and to combine the various components to form such a complete

context as shall seem most probable. In combinations such as these it is extremely difficult to make a clear distinction between what is remembered and what is contributed by imagination and judgment because these parts blend together to form a unitary whole for consciousness. Striking illustrations of this phenomenon are found in errors of testimony, which will be described in the fourth chapter. This process has not yet been sufficiently investigated by psychology. We may call it memorial assimilation; it is wholly analogous with perceptual assimilation which is a much more familiar phenomenon. For even in perception we continually supplement the sensory impressions of the moment by customary ideas which the former arouse, and which seek to fuse with them.

But memorial contents undergo other transformations. They enter into fusions with one another, especially in cases where two groups of ideas closely resemble each other. I have frequently observed that my memory-images of pictures by certain noted painters who deal with similar subjects, for instance paintings by Jordaens and Rubens, fuse so completely with one another that I wholly fail to hold them apart in thought. And then my remembrance of a particular painting by Rubens sometimes becomes a composite of the memory-images of the picture in question and of a similar picture by Jordaens. Phenomena of this sort frequently occur in my experience. In general, it is remembrances of similar impressions which combine with one another in this fashion. Thus our mental images of cities, of mountain landscapes, of similar faces of acquaintances frequently fuse without our being aware of the blending until we find an opportunity to compare the remembrance with the original.[1]

[1] These memorial fusions of similar impressions were revealed in striking fashion in Ranschburg's investigation of the immediate reten-

This mutability of memory-images is inherent in the very nature of memorial processes themselves. Only in very exceptional cases are our memory-images mere revivals of single perceptions. They are, as a rule, revivals of a multitude of perceptions which may have been widely different from one another. Hence our idea of any given object must have come about by a fusion of various perceptions with their several memory-images. Even when I have an idea of a particular thing,—of a personal acquaintance, for instance,—this idea is the revival of numerous particular perceptions in which my acquaintance was seen from different points of view, under different conditions of illumination, in different dress, with different facial expressions, with different movements, with different vocal expressions, etc. Indeed, even in those cases where I have seen a man or a landscape but once, the perception consists of a great variety of details of perception whose contents differ. Out of these the memory-image is built up by a process of fusion. And it is for this reason that memory-images can never be simple copies of things; their contents must be the product of a certain transformation or free combination of several particular remembrances or perceptions. Even those things which have been committed to memory are always acquired as the result of a number of acts of learning; and in each act of learning the idea of the thing undergoes a change. Hence here, too, the idea is the product of a fusion of various impressions.

Finally, our interpretations of phenomena and their emotional values contribute to the formation of memory-images, in that they select certain of the perceived and the remembered elements. This selective activity not only differs from

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tion of numbers. P. Ranschburg, Ueber die Bedeutung der Aehnlichkeit beim Erlernen, Behalten und bei der Reproduktion, *Journal f. Psychol. u. Neurol.* V., 1905, 93–127.

individual to individual, but even in the same individual it varies with the progress of his development and of his knowledge. Thus it comes about that an idea depicts not merely a thing but also my reflection about the thing. Our interpretation of objects, our practical or theoretical evaluations of objects play a part in the formation of our complex ideas without our making any intentional contribution. Finally, many ideas are not mere copies of particular objects; they relate to whole groups or classes of objects which are represented or symbolized by them in consciousness. In such cases many objects, which may be of wholly different sorts, are represented by a single particular idea or by the parts of a particular idea; and by this means the idea acquires "representative universality."

This view of the nature of the idea, which we owe to experimental investigation, is wholly different from the naïve view of the older psychology which regarded ideas simply as copies of particular things. It follows that an idea is not a simple revival of a definitely perceived thing but is always the product of many perceptions and of their subjective elaboration by the perceiver. Hence every memory-image represents a greater or lesser degree of subjective transformation and free combination of impressions derived from perception. Applied to memory this means that memorial activity does not consist in a simple revival of ideas of a former object; but that in every reproduction of an idea, memory is always influenced by numerous former perceptions, by other remembrances, and by a subjective elaboration of former impressions.

From this it may be inferred that particular memory-ideas cannot be traced back to particular dispositions in any such fashion as to make each memorially imprinted idea correspond to a single, definite disposition; on the contrary, numerous traces or after-effects or dispositions of former impressions,

ideas, and the like co-operate in every reproduction of an idea. Of course, this nature of the memory-idea renders untenable the naïve view of certain psychologists, according to whom particular ideas have their seat in particular nerve-cells of the cerebral cortex. Such a complex functional process as the physiological correlate or correlates of an idea cannot take place in a single nerve-element.

It is evident that our envisagement of the idea itself has been profoundly modified by modern psychology. Thus we know that any illustration such as V, V^1, V^2, etc., which represents the successive appearances of an idea in consciousness by means of a series of mathematical symbols is a purely schematic representation, because ideas are by no means such clear-cut and sharply defined structures as these symbols might lead one to suppose.[1]

We know too that in their successive recurrences to consciousness ideas appear in changed form. Every idea is composed of a greater or lesser number of partial ideas; and now one, now another of the components stands out more prominently in consciousness, as a result of the context in which it appears, or of the direction in which the attention is turned, or of the emotion which dominates us at the moment. Hence the manner in which the same idea comes to consciousness varies from time to time. The pattern of these changes is not to be envisaged in the form of clear-cut units arranged as a series of discrete terms, such as is represented by the schema V, V^1, V^2, etc.; ideas are of a fluid character, and we frequently find that there is a constant transition from one into another. It is only when the course of thought changes abruptly, or when new impressions force their way into

[1] The whole Herbartian doctrine of association and reproduction is based upon schematic seriations of clearly demarcated ideas; no such ideas are ever found in the realm of reality.

consciousness, or when something "occurs" to us that ideas or groups of ideas possess this characteristic of sharp demarcation from the other ideas which dominated us at the moment of interruption. But that does not happen in ordinary cases of recollecting and imagining; here the stream of ideas continually pass over into one another, as we shall see in greater detail later.

Even more complete than the transformation in our meaning of the idea has been the transformation which modern psychology has made in the meaning of laws of association and reproduction,—that is, the laws which govern the appearing, the combining, and the recalling of ideas,—which were regarded as the essential basis of memory. Attempts have been made to reduce the number of the laws of association by tracing them all back to a single fundamental law; and the meaning of the term has itself been modified in that the laws no longer refer to inter-connections between discrete and sharply demarcated ideas, but to the phenomena which constitute the fundamental basis of these inter-connections, that is, to the establishment of dispositions to revival. The older psychology assumed that memorial activity is to be explained by means of laws of association. These laws have prevailed in psychology for upwards of two thousand years; but experimental investigation has shown, in recent years, that but slight importance attaches to them. The laws were formulated by Aristotle; and they were retained intact by the mediæval philosophers. At the beginning of modern philosophy we find them again in the systems of Hobbes and of Locke. They were developed in detail by Hume, and they constituted a dogma of the English School of Association Psychologists. Since Hume these laws have usually been formulated as follows: Ideas enter into association with one another *1.* when they are contiguous in space or in time,

(law of spatial or temporal contiguity); *2.* when they resemble one another, (law of similarity); *3.* when they are in contrast with one another, (law of contrast); and *4.* when they stand in the relation of cause and effect, (law of cause and effect). The law of cause and effect is now regarded as superfluous; and the law of contrast is held to be but a special case of the law of similarity because similar ideas are always, in some degree, different or in contrast. The law of similarity is usually reduced to the law of contiguity because when similar ideas are similar by reason of the presence of common components in each, an apparent reproduction by similarity may be due to the fact that the common components of the two ideas constitute a bridge by means of which consciousness passes over from one to the other. But these common components are associated, by contiguity, with the other components of each idea. Hence, as a matter of fact, we have reproduction by similarity only in so far as result is concerned; from the point of view of process, it is a reproduction by contiguity.

Of all these laws of association only that of contiguity is admitted by most modern psychologists; but it is easy to show that this law too is wholly inadequate. The law states that ideas enter into association as a result of their having been in consciousness simultaneously or in immediate succession. Now it may readily be shown that all ideas which were present in consciousness simultaneously or in immediate succession, do not, by any means, become associated and do not subsequently reproduce one another. After seeing a painting or a landscape I am far from being able to reproduce their complete details, although all of these details were pictured upon my retina and were present simultaneously in my consciousness. This simple illustration shows that the law of contiguity is inadequate. It is evident that other

causes must co-operate in order to make simultaneity in consciousness effective in bringing about an association of ideas. Instead of the old laws of association, experimental psychology demonstrates the special conditions under which the association and reproduction of ideas take place. In our investigations of memory we discover the exact conditions of association; and in the reproductions to which we have recourse as a test of retention we discover the exact conditions of reproduction. These experiments enable us to formulate new laws of association and reproduction which specify these conditions.

A statement of these conditions and laws must include three factors:

I. The conditions of imprinting and associating the contents of consciousness, or the establishment of dispositions. These are the conditions of association in the narrower sense. Both of these phenomena,—the formation of dispositions to a subsequent revival of ideas, and the connecting of an idea with other contents of consciousness,—may be designated by a single term: the combining capacity or the associative valence of the contents of consciousness.

II. The conditions of revival of mental processes, or the coming into operation of the dispositions. These are the conditions of reproduction in the narrower sense.

III. The conditions of forgetting, or the gradual fading of ideas and the breaking down of associations and the cessation of operation of dispositions.

The first and the second of these conditions may be bracketed together as conditions of retention; and they may be set over against the third, which concerns the conditions of forgetting.

I. The fundamental conditions of association in the narrow sense are to be found *1.* in the temporal factors which come

into operation in association; it was chiefly these which the old law of contiguity attempted to specify. The temporal factors of association are reducible to three: *a.* Every mental process must have a certain minimal duration in consciousness, if it is to establish a disposition to revival or an association with other contents of consciousness. We sometimes fail to retain fleeting impressions in memory because of their momentary character. *b.* Every mental process must recur to consciousness a certain number of times if security of retention is to be attained. Impressions which have been present to consciousness but once are, in many cases, wholly forgotten unless they made a strong appeal to the attention or to the feelings. *c.* The rhythmic recurrence of impressions and ideas tends to reinforce their retention. When words or tones are repeated in rhythm they are much more durably imprinted upon consciousness. These three conditions of association also constitute three fundamental conditions for increasing the permanence of associations and the valence or strength of dispositions because the longer a mental process is present in consciousness, and the more frequently and the more rhythmically it returns to consciousness, the more intensive is its effect upon memory.

2. A second group of conditions of association is the product of the part played by attention in the processes of consciousness. The direction of our attention to any content of consciousness endows that content with a greater associative capacity or valence. The well-known fact that attention is a significant factor in associative learning is due chiefly to this phenomenon.

3. A third group of conditions of association is due to the influence of the feelings; here too is to be included the influence of the organic sensations which originate in the internal organs of the body and which are intimately connected with

the feelings. Every experience which was attended by more or less intensive feeling or emotion becomes *ipso facto* endowed with greater associative power. It is a familiar fact that occurrences which were intensively tinged with emotion are remembered more readily and in more complete detail; a single component idea,—for instance, some person who was concerned in such an occurrence,—may suffice to recall the whole occurrence to consciousness. In the domain of intellect, however, our feelings manifest themselves chiefly in the form of our "interest" in certain matters; and interest is one of the most fundamental conditions of impression and association. The extraordinary significance which attaches to interest in the imprinting of impressions and ideas upon the mind of the child has always been a matter of prime importance in pedagogy. Nagy has recently called attention to the significance of interest in the memorial work of children.[1]

The second and the third conditions are also significant for increasing and reinforcing associations. The associative power or valence of a content of consciousness increases with increase of attention devoted to it, and with increase of emotion or interest aroused by it. There are, however, certain extreme conditions of internal excitation which constitute an exception to this rule. When the concentration of attention and the intensity of emotion exceed a certain limit they may bring about a decrease of associative capacity; indeed they may give rise to a complete inhibition of association. It seems probable that in such cases the extraordinary degree of internal excitation consumes an excess of psycho-physical energy, which is withdrawn from the intellectual processes. In mental pathology those groups of ideas which are accompanied by intensive emotions and are, at the same time, consolidated

[1] Ladislaus Nagy, *Die Entwickelung des Interesses der Kinder.* Leipzig, Otto Nemnich, 1912.

into groups by the attendant emotion have come to be called emotionally toned complexes of ideas, or more briefly "complexes." (Jung, Ricklin, Bleuler, Freud and others.) That is, the component ideas of any experience which aroused our emotion intensively are consolidated by the emotion into a single idea-complex which now may itself acquire a special significance for consciousness. Occurrences which are accompanied by intensive emotions of unpleasantness are especially prone to form such indissoluble complexes. Our remembrance of a place where we had an especially unpleasant experience, or of a person with whom we had a particularly unpleasant altercation may constitute such a complex. As soon as any fleeting thought of this place or of this person comes to consciousness the whole unpleasant memory-complex tends to force itself into consciousness. And under certain circumstances the unpleasantness which attaches to such an event may become so intensive as to be intolerable. Pathological "suppressions" may then ensue,—that is, we suppress our remembrance of the event which may now disappear so completely from consciousness that we can no longer remember the complex. The doctrine of the "suppression" of unpleasant memory-complexes constitutes an exceedingly important phase of modern pathology, especially in hysteria. This doctrine assumes that suppression gives rise to various sorts of pathological symptoms; it seems as though the emotion, when forcibly suppressed, were seeking to discharge itself in some other fashion.[1]

The topics which we have discussed from these last three

[1] An excellent summary of the much disputed Freudian theories appears in A. Kronfeld's monograph "*Ueber die psychologischen Theorien Freuds und verwandte Anschauungen,*" Leipzig, 1912. This monograph may be found in the *Archiv für die gesamte Psychologie,* XXII., 1912, 130–248.

points of view constitute groups of memorial conditions because temporal relations, attention, emotion and interest are themselves complex phenomena; and they may exercise their influence upon association in very different ways. But a detailed discussion of this topic would carry us too far afield into the general psychology of memory and its special problems.

All of these conditions of association may function for one another, either wholly or in part, in a vicarious or surrogate fashion; and this is exceedingly important for the economy and technique of memory. For instance, the fleeting and momentary character of an impression may be compensated, in part, by increased concentration of attention; frequency of repetition, intensity of emotional accompaniment and concentration of attention are, to some extent, mutually equivalent and interchangeable factors.

II. The special conditions of reproduction in the narrower sense may also be sub-divided into two chief groups:

1. Subsequent reproductions or revivals of contents of consciousness depend, of course, upon all of the factors which contributed to the formation of associations. Hence all three of the conditions of association which we have described are also conditions of reproduction. Every former association into which an idea has entered endows the idea with a tendency to reproduction. These tendencies are of two sorts: *a.* When an idea enters into associative connection with other ideas its own tendency to reproduction is increased because each of its associates may now recall it to consciousness. This we may call a passive reproduction tendency. *b.* In forming associations with other ideas an idea acquires a tendency to recall its associates to consciousness. This may be called an active reproduction tendency. No explanation of the appearance of an idea in consciousness in any partic-

ular case can be adequate unless both sorts of reproduction tendency are taken into consideration.

Every idea may enter into numerous associations with other ideas; and these associations may differ in strength and stability. Hence in explaining any particular case of reproduction we must consider both the sum of reproduction tendencies possessed by an idea, and the manner in which these tendencies co-operate with one another. The combined action of reproduction tendencies depends, in part, upon their content, and in part upon their intensity or strength. For instance, my idea of Schiller has entered into numerous associative connections with other ideas. On hearing the name Schiller I may think of his youthful adventures, of the storm and stress period, of classicism in poetry, of the romantic school of poets, of Schiller's relations with Goethe; I may think of Schiller's idealistic philosophy, of his views on æsthetics, and the like; I may think of such places as Weimar and Jena. Each of these associations constitutes a reproduction tendency which attaches to the name of Schiller; and according to the context in which the idea of Schiller comes to my consciousness one or other of these reproduction tendencies may become effective, either singly or in co-operation with other tendencies. Which of these tendencies shall become effective in a given case depends upon the totality of possible conditions of reproduction, and upon the content and the strength of the reproduction tendencies which attach to the name Schiller. Hence it may even happen that when I hear the name Schiller apart from any definite context, as is ordinarily the case in association experiments, so many reproduction tendencies of this word may crowd into consciousness together that they may inhibit one another; and I may be unable, for a moment, to give expression to an appropriate idea for the very reason that the name possesses such a

wealth of associations. This phenomenon of mutual inhibition of reproduction tendencies which come into operation simultaneously is frequently observed in psychological experiments. Matters are facilitated if we give the observer a particular point of view from which he is to respond by reproducing a word when he hears the stimulus-word. For instance, we may ask: Where was Schiller born? Where did he meet Goethe?

The several reproduction tendencies of an idea may reinforce one another; they may inhibit one another; or their effect upon one another may be in part reinforcing, and in part inhibitory. In the latter case opposing tendencies may appear, giving rise to "slips of the tongue," "slips of the pen," and the like. In an association experiment I once responded to the stimulus-word "picture," with the apparently meaningless reaction-word "Rumens." This phenomenon was due to the presence of an idea-complex which possessed two reproduction tendencies. A short time before I had been engaged in a dispute with an acquaintance regarding the frame (*Rahmen*) of a painting by Rubens,—which was to me unpleasing. The remembrance of this incident made itself felt in two reproduction tendencies,—a tendency to reproduce the word Rahmen and the word Rubens, and this mixed tendency gave rise to the reproduction of the word "Rumens."

2. A second group of conditions of reproduction includes two classes, both of which are characterized by the fact that they are not due to the operation of former associations. A chief error of the older psychology of memory consisted in supposing that ideas can return to consciousness only in consequence of their associations. It is now known that this view is untenable because, on the one hand, the reproduction of a particular idea in a particular case is due not to previously acquired associations but quite as much to factors

which have to do with the present state of consciousness; and, on the other hand, we may in certain instances observe the operation of a wholly different set of conditions of reproduction which render possible the appearance in consciousness of "detached" or *freisteigende* ideas. The former class of conditions may be referred to as conditions which have to do with constellations and with the state of consciousness. Here are to be included those conditions of reproduction which are due to the momentary state of the individual and to the momentary constellation or composition of consciousness. The latter class of conditions may be designated as inducing or actualizing conditions in order to distinguish them from previous associations. The modern psychology of memory contains numerous references to these non-associative conditions of reproduction, but their nature is still obscure.

a. What particular idea shall appear in consciousness in any particular case is a matter which is not determined solely by the associative connections possessed by the ideas which are present at the moment; quite as much influence is exerted by the general condition of the individual, his freshness or fatigue, the fact that he is well-disposed or ill-disposed, the total group of impressions and ideas which are clearly or obscurely present to his consciousness, his feelings, and everything else that may be designated as his conscious constellation. Hence the constellation conditions of reproduction include, as the term indicates, the combined action of all of the non-associative factors which may acquire an influence upon reproduction at the moment when reproduction takes place; this embraces all the feelings, efforts, ideas, impressions, and the like, which make themselves felt at the moment, and to these must be added the general condition of the individual. The detailed investigation of these conditions of

reproduction is one of the future problems of psychology. At present we are in possession of relatively few experimental observations which can give us an insight into these exceedingly complicated conditions of reproduction.

b. The apparently "free" emergence into consciousness of a (detached) idea is a phenomenon which is equally incapable of being explained from former associations. And this phenomenon also has not yet been sufficiently investigated; its existence, however, can not be doubted. Ideas come into consciousness through the medium of their former associations, without being aroused by the dominant ideas of the moment; on the contrary, they break in upon the prevailing train of ideas. The only point concerning which there can be any doubt is the question as to whether they are not to be explained from a complicated co-operation of manifold factors of association. Meanwhile it is important to describe these phenomena, making a clear distinction between the specific nature of this phenomenon of alleged "free" ideas and the question as to whether they can be explained. These two problems are not always distinguished with sufficient clearness in psychology. For instance, although G. E. Müller has established the existence of phenomena like perseverations as facts, this does not prove that they constitute a special cause of reproduction. These considerations will be more readily understood if we cite the four cases in which an apparently free emergence of ideas can be established: perseveration, persistence, iteration and automatic reproduction (or reproduction as a result of automatization).

G. E. Müller employs the term perseveration to designate the following phenomenon: An idea upon which we have concentrated our attention acquires the capacity to re-enter consciousness immediately thereafter and even to break in upon the course of ideas to which we have meanwhile directed

our attention, although it seems to derive no associative support from the ideas which dominate us at the time of its reentrance. For instance, words or syllables which we have learned in a memory experiment may subsequently force their way into consciousness while we are applying ourselves to the learning or the reciting of a wholly new group of syllables or words. Phenomena like the following are more familiar: After reading an unpleasant letter and returning to our work we frequently find that the remembrance of the letter interrupts our work; and the interruption may recur again and again with irresistible force. Such a remembrance has acquired perseverative power; it persists in consciousness with its reproductive tendency, and it breaks in upon our prevailing ideas although it is not supported by any associative connections with them. In such cases the entrance of the unwelcome idea seems to be a "free emergence," because it seems to break in upon us instead of being introduced in an associative manner.

I cannot here discuss the difficult problem as to whether such phenomena as perseveration are really incapable of being explained from the general laws of association. I can only point out that in the most of the phenomena of this sort which have been described it is not difficult to find an explanation from the general laws of association. The remembrances of the unpleasant letter may have acquired their reproductive tendencies from the fact that the emotion and the mood produced by the letter, and the concomitant organic sensations continued to persist after I returned to my work; and the memory-ideas were reproduced from this lower stratum of consciousness which had become intimately associated with the ideas of the letter. This mode of reproduction would be possible so long as the mood persisted. The intrusion of syllables and words in memory experiments may

be explained from the fact that the general situation has remained unchanged in the two experiments, and that the new syllables and words contain numerous points of similarity with the old. But however that may be, we do not wish to discuss the causes of "free" ideas here; we can only describe the various cases of "free emergence" as such. And in doing so, it is important to define more clearly the meaning of perseveration or persistence of ideas because the term has been employed to include wholly different phenomena.

1. By perseveration I mean only that emergence of ideas which consists in the fact that shortly after an idea has disappeared from consciousness it possesses the capacity to force its way into consciousness again, and to interrupt the prevailing course of ideas. The essential conditions for this are that we have concentrated our attention long and intensely upon the idea, that the idea has excited our feelings intensively, and that the circumstances which formerly brought about the reproduction are still, at least partially, present.

2. By persistence I mean a wholly different phenomenon. It designates the fact that under certain circumstances,—for instance, when we are fatigued or otherwise unfavorably disposed in body or in mind,—our ideas and our activities tend to become repetitive and persistent because we no longer possess sufficient energy to apprehend differences or to react in a discriminating fashion. In experiments dealing with the reproduction of ideas, a fatigued observer tends to acquire a persistent form of verbal apprehension,—mere successions of auditory ideas without meaning,—or a stereotyped form of verbal response,—rhymes or transpositions.

3. The phenomenon of iteration is different from both of the foregoing. It designates the fact that ideas force their way into consciousness and tend to break in upon the prevailing course of ideas, which is then characterized by a

frequent repetition of the same ideas. It ordinarily appears in the form of a repeated intrusion of melodies, of rhymes, or even phrases or single words which persist in "running through one's mind."

4. A fourth phenomenon of this group is the free emergence of ideas as the result of an automatization and mechanization of psychical and psycho-physical functions. It manifests itself most frequently in the motor domain, where the rôle of the automatized and mechanized functions is especially noticeable. At times its effects seem to be identical with those of iteration; but it seems to be due to a wholly different complex of causes. Its origin is invariably to be found in the frequent execution of activities which thereby become completely automatized. For instance, certain manipulations of apparatus have to be repeated over and over again in an experiment. When a second experiment is undertaken we involuntarily repeat the manipulations of the former experiment. Similar phenomena may be observed after shifting from any activity in which facility may be acquired; if after conversing in French we begin a conversation in German, we soon find that we have involuntarily dropped back into the use of French.

It is to be borne in mind, however, that all of the laws of association and reproduction, as well as of the conditions of memory in general, are probably quite as valid for motor as for intellectual processes; and hence we may speak of motor memory and of motor reproduction. A familiar illustration is to be found in the case of the practised pianist. His fingers are able correctly and automatically to hit upon the most appropriate fingering even for the different scales.

The terminology which is customarily employed in the psychology of memory is not wholly free from objection. The term reproduction of ideas is misleading in that the reproduc-

tion of an idea is not always the mere revival of a former idea. Unfortunately we also employ the term reproduction to designate the free activity of combination which is characteristic of productive imagination and thinking, and which is essentially a matter of new combinations of ideas. And even the purely memorial reproductions of former ideas are genuine reproductions only in very rare instances; here, too, as a rule, the impressions and ideas derived from our former experience have been re-shaped and re-cast. It is incorrect to employ but a single term to designate all of these varieties of emergence phenomena. Moreover, our extension of the meaning of the term makes it impossible for us to designate specifically the genuine recurrence of any idea where it is our intention and purpose to re-experience the idea in unchanged form. I shall, therefore, apply the term reproduction only to those cases of appearance of ideas where a genuine revival of former ideas actually occurs, and where the intention to revive and not to re-combine is present. My general expression for the entrance of ideas into consciousness will therefore not be the word reproduction. But when I want to emphasize the movement aspect of ideas I shall employ the terms "emergence" or "entrance" (or actualization) of ideas into consciousness; and when I have in mind any sort of spontaneous activity on the part of the individual I shall employ the term "evoking" (calling up) of ideas.

The meaning of laws of association has undergone a second change. If the nature of memory is conceived to consist not in some sort of a storing of ideas, but in the forming of dispositions to their more ready revival,—or expressed more generally and more correctly, in the forming of dispositions to a more ready revival of everything that has ever been present to consciousness,—it follows from this fundamental view that the laws of association and reproduction are to be regarded

as laws which have to do with the formation and the operation of memorial dispositions. The actual fixative and retentive function of memory must then be regarded as consisting in the establishing and reinforcing of these dispositions; and the effect of memorial activity,—that is, the reappearance of former ideas in consciousness, or the more ready revival of former impressions or actions,—is then to be conceived as a realization or actualization of dispositions which have been formed at some previous time.

Hence all causes, conditions and laws of memorial function are to be represented as causes, conditions and laws of the formation of dispositions and of the actualization or coming into operation of dispositions. The whole psychology of memory may then be developed in the form of a doctrine of the laws of the establishment and the operation of memorial dispositions.

But however logical and consistent may be our presentation of a psychology of memory in terms of the formation and operation of dispositions, it suffers from one serious defect. It is, to a certain extent, a psychology of the future because the nature of these dispositions is but slightly known as yet. The introduction of such concepts as increase of mass, modification of structure and change of molecular arrangement in the bodily organs concerned furnishes only a partial insight into their bodily substrates. From the psychical point of view, memorial dispositions consist in nothing more than effects of memorial functioning,—in changes which we see manifesting themselves in ideas and courses of ideas rather than in any "substrates" of ideas.

Having attained this clearer conception of the nature of dispositions we must now describe the results of the memorial investigations of the past in terms of the establishment and the functioning of dispositions; and the same mode of envis-

agement must direct our efforts in the future investigation of memory. Whenever a new result is obtained we must inquire whether it can serve to define more definitely the nature of the physical and the psychical dispositions of memory. But the present state of our views concerning the nature of dispositions does not justify us in presenting the whole psychology of memory as a theory of dispositions because we would either conceive the dispositions as physiological substrates of memorial function,—in which case our investigation would be transformed into a physiology of memory,—or we would have recourse to a vague and general conception of dispositions which would include both the physical and the psychical, —in which case our psychology of memory would amount to nothing more than a collection of statements concerning a vague and indefinite word. Or we might start from the concept of psychical dispositions,—the only legitimate concept for our purposes. From this starting-point the whole theory of dispositions becomes identical with a psychology of memory conceived and developed as a theory of ideas, combinations of ideas, and revivals of ideas; and we can obtain a knowledge of the dispositions, in their psychical aspects, only when we have determined what are their effects by observing ideas and the modified flow of ideas.

In my opinion, then, a theory of memory, association and reproduction should always be brought into relation with the psychical effects of memorial functioning; and these latter may always be discovered by an introspective study of our ideas and their course. But meanwhile, in opposition to the older psychology, we must never lose sight of the fact that the nature of ideas and of their modifications is itself of a "dispositional character,"—that is, that they are changeable mental processes which, under certain circumstances, may recur to consciousness in approximately similar or

identical form, and that from the psychological point of view, memorial activity here consists simply in certain relatively constant changes in the psychical conditions of this revival of ideas.

For the psychologist who seeks to avoid superfluous hypotheses, therefore, the doctrine of memory dispositions is nothing more than a theory of persistent change in the conditions under which ideas may be reproduced or revived.

It may be asked: Can we not discover the general nature of memory from the universal tendency of memory to form associations between ideas in consequence of dispositions to revival? Here again the only satisfactory answer must come from the facts of memory itself. We find that memorial activity tends to fuse into a unitary whole the elements, impressions or ideas which have hitherto not been united for consciousness. Hence memory eliminates the discrete and disconnected character of the particular processes of consciousness and blends them into one. The more perfectly the associative function does its work, the more nearly does the associated group of ideas become a completely unitary whole, and the more closely does the reproduction of such a group of ideas approximate a unitary state of consciousness. This manifests itself in the phenomenon that in a poem which has been thoroughly memorized we can pass directly from any part to any other part. The succession of elements and the successive character of the associations have been eliminated; we have attained as complete a mastery over such a perfectly memorized poem as over any manifold whose parts are all present to consciousness simultaneously. The poem has simply become a single unit for consciousness. And, in a series of nonsense-syllables which has been securely learned, we can pass over equally well from the first syllable to the second, from the first to the sixth, and from the first to the

twelfth. The successive character of the syllables has been eliminated; the series of twelve has become a simultaneously present unit.

And this constitutes the ultimate reason for the phenomenon that impressions and ideas which were formerly discrete and isolated may now reproduce "one another." When such elements as German words and their English equivalents, or the words of a poem, or the syllables of a series have been so thoroughly learned that they really form a unit, it is self-evident that when one part of these elements appears the other elements must also appear. The complete unitary content of consciousness into which these securely associated elements have been fused is revived. Hence the nature of memory consists in its being a formative activity which combines processes of consciousness, which formerly were isolated, into a unitary state of consciousness. Höffding expressed a similar view when he designated the "fundamental law" of association as a "law of totality."[1]

If we carry this conception over to the dispositions we may say that the function of memorial dispositions is essentially synthetic in character; their nature would be designated more accurately if we called them unifying dispositions. We might also describe them as fusion dispositions because in the psychology of tones the production of a unitary content from a close combination of elements is designated a psychical fusion, where the elements constitute a new unitary state, it is true, but still they persist as relatively independent elements, —for instance, the tones in a chord.

III. There is in a certain sense an opposition between the conditions and laws of forgetting and the conditions and laws of retention; the two are to be conceived somewhat as inverse or reciprocal processes. The laws of forgetting have been sub-

[1] H. Höffding, *Psychology* (trans.), 1892, 159.

mitted to experimental investigation within recent years; special efforts have been made to determine and to reduce to definite laws the progress of forgetting with the lapse of time.[1] It has been found that immediately after the act of learning, the progress of forgetting is rapid, but thereafter it gradually becomes slower and slower. Short series of ideas are forgotten more rapidly than longer series; long stanzas of poetry are remembered better than short stanzas, all other conditions being equal. Efficiency of retention is improved by practice in learning and reproducing.

The phenomena of forgetting may be brought into relation with the psychology of dispositions. It would be conceived that memorial dispositions gradually decrease in intensity or valence, losing their power to bring about reproductions and finally become "latent." This means that their effectiveness is finally to be conceived as being so slight that one can no longer be sure that they still exist,—because we must never lose sight of the fact that they manifest their existence only by their capacity to revive ideas. Now since, theoretically, complete forgetting does not take place until an infinitely long interval of time has elapsed we must assume that a memory disposition, when once established, never wholly perishes but only becomes infinitely weak,—that is, its effectiveness finally exists only in latent form.

But it must be admitted that a dispositional psychology of memory is exceedingly open to question. In the first place, it brings with it the danger of rehabilitating the old doctrine that the gradually fading dispositions are entities which exist in concrete and substantial form, and that they are to be

[1] H. Ebbinghaus, *Ueber das Gedächtnis*, Leipzig, 1885. P. Radossawljewitsch, *Das Fortschreiten des Vergessens mit der Zeit*, Göttingen, 1907; this monograph was also published under the title *Das Behalten und Vergessen bei Kindern und Erwachsenen*, Leipzig, 1907.

conceived as being somewhat analogous to physical bodies which wither and decay, or to chemical substances which volatilize and decrease in mass. Then, too, the advocate of such a theory tends to lose sight of the fact that all that we can ever know of the phenomena of forgetting is revealed through its psychical effects. These effects consist exclusively either in certain modifications which take place in the ideas themselves,—they become more indistinct, more fragmentary, less distinguishable from other ideas,—or in certain changes which take place in the conditions under which ideas make their appearance in consciousness,—their associations with other ideas become unstable and insecure, and in consequence of their weakened associations they possess a lesser tendency not only to return passively to consciousness, but also to participate actively in arousing other ideas.

CHAPTER II

THE FUNCTIONS OF MEMORY

Since the general principles of memorial functioning have been discussed in the preceding chapter we may now raise the question as to whether it is possible to distinguish a variety of special functions within the general function of memory.

The study of consciousness never reveals the existence of a memory as such; it can only reveal the existence of particular modes of mental activity which possess memorial characteristics,—such as the remembering of concrete objects, the associative learning of verbal texts, and the like. These modes of activity are classified under the heading of memory because they all possess certain characteristics in common which differentiate them from all other mental functions. It is now our problem to discuss these various sorts of memory activity which we too may call memories, and then to answer the question: In what sense may one speak of a general memory as an actual fact of consciousness, apart from and in addition to these several special memories?

In classifying memories, as in every other sort of classification, it is possible to proceed in various ways, and to employ different principles of classification. From the point of view of means employed in the memorial acquisition of data we may differentiate three chief classes of memorial function, which may be called *1.* the activity of noting impressions by means of observation alone,—or *observational learning*;[1]

[1] This species of memorial acquisition (*das beobachtende Merken*) can scarcely be called learning in any strict sense of the term. We shall usually refer to it as observational noting. The phenomena of rational learning will be discussed under the heading of associative learning; see Chapter VI, especially pages 290-313. *Tr.*

2. the activity of learning impressions in consequence of the associations into which they have entered,—or *associative learning;* 3. the activity of remembering experiences in consequence of our discovering their interrelations,—or *rational learning.*

1. *Observational noting.* This function of memory comes into play when we imprint the contents of perception as such, —things, persons, the processes of nature,—by means of observation in order to incorporate them into our memory. Its chief significance in the school-room is found in the object-lesson, in nature study, in geography,—in short, wherever observation is the chief means by which the learner acquires the idea that he imprints upon his memory. Within the function of observational noting we must recognize differentiations which are due to the employment of different sense-organs. For instance, one may observe by means of vision, hearing, smell, taste, or by means of the cutaneous and kinæsthetic senses. The "lower" senses need scarcely be taken into account in the work of the school-room, although under certain circumstances it may be important to observe and to remember the taste and smell of objects if they are to be apprehended in complete detail.

Our knowledge of observational noting, and of its significance in contributing to our remembrances is due chiefly to investigations of sense-memory, of testimony, and of the apprehension and impression of temporal and spatial relations; in recent years, however, the function of observational noting has itself been submitted to experimental investigation. Light has been thrown upon this function by certain incidental experiments where the procedure consisted in asking an individual to observe and to remember a number of objects; and information regarding this function has also been obtained from the experiences of every-day life and of

the school-room. It must be borne in mind that observational learning comes into play wherever one is concerned with the imprinting and remembering of any sensory material in its temporal and spatial relations. Hence not only are the various forms of object-teaching to be included under this type of memory work, but even such activities as the learning of a melody by hearing or singing it, the learning of the forms of objects and of geometrical figures by drawing them, and the like, are also to be included here because the act of observing is the chief means of memorial acquisition, and the learning of sensory material is the chief aim throughout.

2. *Associative learning* is that activity of memory which might also be called *verbatim* memorization or learning in the narrower sense. The really effective factor in this sort of memorial imprinting is not sense-perception, single or repeated, but the attentive repetition, in reproduced form, of a given series of ideas. This type of memorial imprinting occurs in all true learning, especially in memorizing the words of a text. In this type of learning in the narrower sense, the words which we perceive visually or orally or by both of these means serve to convey meanings to us. And it is these ideas of meaning and their logical connections which we wish to retain in memory; only in certain borderland cases, as in the learning of historical dates or foreign vocabularies and in the verbal memorization of formulas or poems, do we imprint the words themselves upon memory. But even in such cases as the learning of foreign vocabularies, we are not concerned with remembering the sense-impressions of the visual or auditory words, together with all the incidental circumstances under which they were presented to our senses; we have no desire to remember the peculiar character of the print or of the script, the form of the letters, or the quality and the cadence of the speaker's voice; those are matters of sense-perception

and observational noting. The perception of the word now serves only to bring to consciousness the verbal idea and its meaning; hence the word as perceived by the senses is only a means to an end, an instrument for the arousal and imprinting of ideas. Here we never note the word itself merely as a sound or as a picture. In short, the sensory content is but a means which serves to arouse and to conjoin an idea content; and only the latter is imprinted upon memory, the sensory content being neither heeded nor imprinted. Thus in observational noting the attention is directed to the details of the sensory content; while in associative learning we attend only to the idea of the words and their meanings. Several different characteristics of associative learning show that the direction of attention is here wholly different from its direction in observational noting, and that the intent of the learning and the adjustment of attention have wholly different objective points in the two cases. In reading a text or in listening to words which we read, we fail to notice misprints and mispronunciations,—a proof that our attention is concentrated not upon words, but upon the ideas which they convey. In observational noting, on the other hand, the accurate apprehension of the sensory impressions themselves is the aim and the goal of the act of learning.

The chief means employed by memory is therefore different in the two cases. In observational noting the perception or observation itself is the essential means of imprinting; in associative learning, on the contrary, the essential means consists in an attentive apprehension, an understanding, and a repeated imprinting of the ideas.

Every such variation in purpose and in means of learning brings with it a variation in the whole character of the memory process and a variation in the conditions upon which it depends. In observational noting we are active chiefly in a

perceptual fashion; and attention comes into play to analyze and dismember the object perceived. When we learn by reading or by listening, we are active in an ideational fashion. And since our attention is no longer directed to the perceptual content, this content is received in a cursory and indifferent manner; it is these ideas as such, and particularly ideas of meanings of words, which now dominate our consciousness. The detailed conditions of these two activities will be dealt with in a subsequent discussion of the technique of observational noting and of true learning.

3. Memorial imprinting may be of a third sort; it may be characterized by an act of rational and reflective apprehension, as when it deals with connected contexts of ideas or thoughts. This process of rational combining serves to imprint a connected train of thoughts. This third type of learning comes into play when, without memorizing it word for word, we endeavor to remember the content of a description, an anecdote, a scientific treatise, a lecture, or the like. When material of this sort is learned *verbatim*, the associations between the words become the chief factor upon which memory relies. It is characteristic of rational learning, however, that it abandons, in greater or lesser degree, its reliance upon verbal factors; an understanding of the concrete or logical relations among the ideas and thoughts now constitutes the essential means of remembering the material. The visual and auditory perception of the mere words plays a less important rôle in this sort of imprinting than in associative learning. The ideas of the words, indeed even the original order of presentation and the particular meanings which we attach to the words of the original text are a matter of indifference to us; the only essential thing is to learn and subsequently to reproduce the thoughts or the context of ideas. That is, the exact form and the exact order in which the words and mean-

ings of the original were arranged becomes a matter of no moment to us; all that is required of us is that we shall be able to reproduce in our own words a context of ideas whose meaning shall be similar to the meaning of the original text. In this sort of learning then, the attention is directed upon the concrete or coherent train of thought, not upon the medium or form of expression.

This is the method of learning which is employed by the adult in dealing with by far the greater part of the material which he wishes to remember. In the retention of material presented to him through the medium of books, magazines and the conversations of his fellow-men, he makes no attempt to note accurately the words, the verbal order, or the diction; the sole purpose of his endeavor is directed toward the end that he shall subsequently be able to reproduce thoughts equivalent in value and in meaning to those expressed in the original book or article or conversation. This explains why the adult is able to remember great masses of material without repeated memorizations, while the child, who is much less able to rely upon his logical memory, is instructed to make at least a partial use of a more *verbatim* type of learning. As a rule the adult, in his scientific reading and in his reflection, assumes that if he once understands a train of thought, this will suffice for its permanent retention, and repeated imprinting is unnecessary. However, when a connected material has thus been learned by understanding it or by reflecting upon it, it is well to return to it occasionally and refresh the memory by reviewing the material as accurately as possible; but, as a matter of fact, we remember much which has never been reviewed in this manner. This extraordinary capacity of logical memory in adults, which enables the scientist to retain almost the whole body of knowledge which belongs to his science, is to be explained chiefly from two circumstances:

a. The memorial material which we here acquire need not be learned or remembered in the original form in which it was presented. This saves the memory a great mass of detailed impressions, such as the particular words and the particular literal meanings of sentences, their sequence and their grammatical form. All of that we allow to drop out as useless lumber; we draw off a sort of extract which contains the essential points in the development of the thought. This we imprint once more during the process of bringing it into relation with general points of view, which again serve as clues for a subsequent re-acquisition of the particular details. In this manner we note in a scientific work only the chief thoughts and these in as brief form as possible; with these as a starting-point we can readily reconstruct the content in detailed form. *b.* A second reason for the enormous capacity of memory is to be found in the fact that although no repetition or refreshing of the original content takes place, still the scientific thoughts which we have once mastered can always be revived and reproduced because they stand in relation with numerous other contexts of thought. For example, when I have learned the essential content of a work on logic or epistemology, certain thoughts contained in that work are recalled to mind whenever I read another work dealing with a similar topic; and by this means they are re-imprinted upon memory. Hence anything that has become assimilated into the context of our conceptional knowledge requires no verbal or other detailed renewal because it has entered into numerous logical relations with other conceptual contexts, and is reproducible through the medium of the latter at any subsequent time.

From the second point of view, we distinguish between *a.* immediate, *b.* temporary, and *c.* permanent retention; or more strictly speaking, between *a.* the immediate reproduc-

tion of impressions which have just been received, *b.* retention for a short period of time, after which the material is forgotten, or retention for a single given interval, and *c.* permanent incorporation in memory, which results from an intention to make a given content a lasting or imperishable possession of mind. Immediate retention should rather be called the restoration, without delay, of impressions which have not yet wholly disappeared from consciousness; and permanent retention might be called the delayed revival of impressions which had already disappeared from consciousness. The former represents immediate, the latter, delayed reproduction.

These distinctions are based upon general considerations as well as upon experimental observations. They have been disputed, it is true, but, I believe, for insufficient reasons. Opponents of these distinctions usually maintain that these three functions of memory are not radically different, but that transitions may be found between immediate and permanent retention. That is self-evident; but it does not constitute a valid objection to the distinction. In not a single instance where particular functions within the intellect are differentiated can we have to do with wholly incomparable functions which possess no characteristics in common, and which show no transitions or gradations from one into another. It is possible, for instance, to indicate a great many characteristics which are common to memory, to imagination and to thought; and we can find common elements and transitional stages in external and internal perception, in sensation and reproduction, etc. It is inherent in the very nature of psychological classifications that they cannot refer to radically different sub-divisions of different functions because they are nothing more than logical epitomes of differentiations within a consciousness which is essentially unitary; and again

if we make distinctions within a given function they are, after all, nothing more than differentiations of the function itself. The objection in question might equally well be urged against every sort of psychological classification. Immediate and permanent retention are distinguished by such strikingly different characteristics that no one who clearly understands what psychological classification means can doubt the validity of their differentiation.

The distinction between immediate and permanent retention is based upon the following reasons: *1*. It designates, in the first place, a difference in the intention with which we learn the material to be remembered. It may be our intention to reproduce it immediately after the completion of the act of observing it. This is the case when we attempt to repeat letters or numbers which have been pronounced in our presence in order to test our capacity for immediate retention; or when, on a question being asked us, we attempt to retain the question just long enough to answer it; or when we read the names on shop-windows, in order to get our bearings in the business section of the city, etc. In none of these cases could any useful purpose be served by a lasting retention; and in such cases we always make the observation for immediate use, and never retain it permanently, nor even for any considerable period of time. In experimental investigations, immediate retention is usually tested by pronouncing letters, syllables, or words, and having the observer speak or write them without delay.

2. A second characteristic of immediate retention consists in the fact that it is, to some extent, a restoration of the original impression which has by this time partially faded. Immediate recall makes use of the dying away of the original impression itself, and hence it has in some degree the character of an after-image, as when a color stimulus after ceasing

to act upon the retina is succeeded by an after-excitation in the visual organ and in the visual center, and tails off into an after-image which may last for several minutes. When we concentrate our attention upon such an after-image we are able to check its fading and lengthen its duration by this artificial means. In a similar manner, immediate retention,—for instance, the reproduction of words which have just been heard,—employs all the particular details of the original impression. I still seem to hear the sound of the speaker's voice, the tempo, the rhythm, and the accent; or if the words were presented visually, all the details of the incidental circumstances which attended the perception still remain in memory, and are all made use of by immediate retention. Indeed this persistence of the complete details of original impressions really constitutes the chief aid in this form of retention. All of these concomitant circumstances of the original impression fall away when the reproduction is delayed for several days, weeks or months. Watt has pointed out that lasting retention may also arrest these details and he urges this as an objection to the distinction which we have made. He overlooks the fact, however, that it is not a question of whether these details may be revived and renewed, but of whether immediate retention can make use of the fading-out of the primary impression itself. This is the essential point.

3. And with this is connected a negative characteristic of immediate retention. It is the only form of revival of an impression which takes place without the original impression being crowded out of consciousness; all permanent retention takes place after the original impression has been effaced or has been forced out of consciousness by other ideas or perceptions. Immediate retention is, therefore, not a genuine reproduction, but only a re-inforcement or re-intensification of the fading primary impression. Against Watt's objection we

may also urge the fact that one finds it wholly impossible to retain permanently all the details and accidental circumstances which attended the original impression. It is a chief characteristic of forgetting that these non-essential details are reproducible only immediately after the disappearance of the original impression; they necessarily disappear from memory afterwards. Immediate retention, therefore, still possesses some of the freshness and detail and completeness of the original sense-impression itself, which are wholly lacking in the case of delayed reproduction.

4. An intensive and uniform concentration of attention is the chief requisite for immediate retention. The essential condition of permanent retention, however, is a product of the temporal relations of the process of imprinting, but especially of an adequate duration and an adequate repetition of the impression.

5. The effect of immediate retention is peculiar in that it lasts for only a brief period of time, and that it may readily be obliterated by distracting impressions. This indicates that immediate retention is really nothing else than a re-inforcement of the fading impression. Thus, in experiments dealing with the compass of immediate retention we find that fifteen to twenty seconds after the stimulation has ceased the observer is able to reproduce but little; and it sometimes happens that everything is forgotten a few seconds later, especially when the amount of material presented approaches the limit of immediate retention. If ten or twelve letters are pronounced in the presence of an observer, and if the reproduction is delayed a few seconds, the observer sometimes finds that he is no longer able to recall any of the letters. So, too, when disturbing stimuli or distractions of attention occur during the imprinting or immediately after the presentation of the letters, the whole series of imprinted letters may disappear

immediately and completely from memory. These phenomena can be explained only on the assumption that no fixing of a genuine memory disposition had as yet taken place; and that all that occurred was a dying away and a revival of the primary impression.

6. Our distinction is also justified by the circumstance that the capacity of immediate retention is a variable individual endowment. Certain persons possess a remarkable capacity of immediate retention but a very weak memory so far as permanence of retention is concerned, and *vice versa*. Finally, the two capacities differ even in children, at a time when the child's memory far excels the adult's in permanent retention, and his capacity of temporary retention is still much inferior to that of the adult. This again shows that permanent retention does not depend primarily upon the function of attention, because attention is much less highly developed in children than in adults.

Temporary retention may be distinguished as a special function of memory only with regard to two characteristics: The learner does not here intend to retain permanently, but only for a limited time; and this intention exerts a definite influence upon the processes of imprinting, and upon retention itself as well. This is the way in which we learn poems which are to be recited at a stated time, or prepare addresses which are to be delivered but once. Every public speaker must set about his work of memorizing with this intention in mind. In other respects the difference between temporary and permanent retention is not great. But we shall later discover several reasons for taking this difference into account. It shows how significant for retention is the sort of attitude and the sort of intention with which we learn. We need not consider permanent retention further at this time, because we shall describe it more completely in all of our subsequent discussions.

In the third place, we may distinguish the functions of memory from the point of view of subject-matter retained or of content dealt with. Here it must be noted that the differences of memorial function whose existence we are led to assume by differences in the content retained are also, as a matter of fact, to be regarded as functional differences in memory,—because there is no such thing as general memory but only a variety of special memories. When we attempt to sub-divide memorial functions in accordance with the subject-matter retained, numerous differentiations of memorial activity may, of course, be assumed; and we must gather the objects (and the functions) of memory into groups if we are to avoid a too extended classification. From this point of view, we may first distinguish sensory-concrete memory. This includes: *a.* The sense-memories, which may again be sub-divided upon the basis of the different sense departments. Thus, we may distinguish tonal memory, memory for colors and brightness, memory for tastes, odors, pressures, temperatures and kinæsthetic sensations. *b.* Memory for spatial and temporal impressions. Here we may distinguish between memory for small, immediately perceptible extents of space and of time,—for instance, lines a few centimeters long or temporal intervals extending over a few seconds, —and memory for complex spatial and temporal relations. *c.* Memory for concrete objects and processes as wholes, for things and events in the external world, as unitary groups of sensory qualities. From these must be distinguished *d.* memory for abstract signs and symbols, for names, numbers and abstract verbal meanings; and *e.* memory of our own mental life and its processes. This latter may again be subdivided into memory for products of our ideation and thinking, and memory for emotions and volitions. These latter may also be called emotional and volitional memory. When

volitional memory is concerned with external voluntary movements, motor associations contribute to its functioning.[1]

If we employ the physiological point of view as the basis for differentiating the varieties of memory as regards content, the special memories may be classified into two groups: *1.* The different varieties of sensory memory; and *2.* the varieties and functions of motor memory. Everything which concerns memory of sensations, ideas and thoughts belongs to the class of sensorial memory function. Opposed to these stands memory of motor innervation of movements. It need not be mentioned that motor processes leave traces or dispositions in nerve and muscle just as do the sensory processes in the sensory nerves. In this sense we may, of course, speak of a motor memory.

The former classification from the psychological point of view is, however, more appropriate because it is based upon psychical differences of memory functions, and hence it corresponds more closely with the facts of the mental life. Thus, for instance, it is better to speak of a memory for volitional acts than of a memory for motor functions, because a memory for acts of will includes not only the remembrance of motives which comprise ideas and emotions; it also includes a memory of the movements corresponding to the acts of will. But if, on the other hand, we emphasize the motor aspect of memory, we dismember components which are necessary constituents in the act of will.

Various objections may be urged against employing the sort of content remembered as a basis for a psychological classification of memories. In the first place it might be objected that, after all, we would then be dealing not with different sorts of memory but only with different sorts of remembered content. But there are no peculiar sorts of

[1] *Cf.* p. 26.

remembered content to which special memorial functions do not correspond. Our memory for numbers is something different from our space memory or our tonal memory. It might be objected further that these differences of detail could be multiplied indefinitely. Thus one might also distinguish between memories for different sorts of movements, such as writing movements, gymnastic movements and the like, or memory for sensation differences, etc. This, of course, can not be disputed; but in every classification it is necessary that groups of related processes be included under a single sub-division. And there are numerous other reasons which justify this division. In the first place, memorial functions differ from individual to individual. There are individuals who possess an unusual and one-sided tonal memory; others, a remarkable memory for names, for numbers, etc. Secondly, the several memories differ in their development in children, certain memories developing at an earlier age than others. Thus, in children, the memory for emotions and the memory for numbers and abstract concepts remain relatively undeveloped for a considerable time; while the memory for concrete objects precedes all others.[1] Finally, the various memories may differ in characteristic ways in cases of pathological disturbances of memory function. It is found that the memory for certain particular objects may be disturbed or destroyed while the other memories remain intact.

[1] This was shown by H. Netschajeff, Die Entwickelung des Gedächtnisses bei Schulkindern, *Zeitschrift f. Psychologie*, XXIV., 1900, 321–351.

CHAPTER III

OBSERVATIONAL LEARNING: THE TECHNIQUE OF OBSERVING AND NOTING

1. *Analysis of Observational Noting*

Observational noting comes into play, as we have seen, when by an act of observation we imprint the contents of perception,—persons, things and processes,—with a view to remembering them. It may have to do with the imprinting of single sensations,—colors, pressures, temperatures, odors, tastes, sensations of movement; with groups and complexes of sensations,—combinations of colors, tonal chords, etc.; with sensation-differences which have been made a special object of the act of comparing; with spatial relations, such as the arrangement, position, distance and size of objects; with forms, or specifically with differences of spatial relation, such as the relative length of lines, the relative areas of surfaces; with temporal relations such as the succession of particular events; or with the combination of spatial or temporal relations and sensations. For example, when I note the size, the color and the tactual properties of an object, I apprehend a combination of spatial relations and sensational elements; when I note a part of a melody by simply listening to it, my noting includes the tones, the tempo and the rhythm.

It is to be borne in mind here that in those cases where we note not only the sensations or the temporal and spatial elements in themselves, but also note the total impressions, and where therefore, objects, events, successions of tones, etc., must be imprinted as wholes, we never remember merely

the elements which constitute the whole but also the total impression. This total impression which is superadded to the elements as a special increment has appropriately been called the "form quality" (*Gestaltsqualität*) in an attempt to express the fact that a composite stimulus,—for example, a variegated cube,—makes a characteristic impression as a whole, and to some extent has a special property or quality as a whole which is something more than the several attributes of the elements,—the color, the hardness, and the form of the surfaces of the cube.

As we have already seen, observational noting plays an exceedingly important rôle in memory. It comprises the whole of sense perception in so far as the latter is concerned in the acquisition of information which we wish to incorporate in memory.

To make clear the mechanism of observational or concrete noting, it would be necessary to discuss the whole psychology of perception and observation. By observation I understand a perception which is distinguished from unsystematic and purposeless sensing by the fact that the observation always has some definite goal in view, which guides the observation in a particular direction, and which, during the act of observing, prescribes the point of view or points of view from which the observed object is regarded. And secondly, in consequence of this, the attention is directed toward a definite selection of sense-impressions, while those other impressions which do not fit in with the purpose of the observation remain unnoticed. Thirdly, the result of the observation is also subordinated to certain points of view and is systematically brought into relation with our previous knowledge. One may say briefly, then, that observation is a process of attentive and methodical sense-perception which is carried through systematically from definite points of view.

It would perhaps be well to describe the various parts or stages of such a methodical observation. Let us choose, as an illustration, the observant analysis of some art-product where we purpose to determine the period from which it dates, the style which characterizes its form, and perhaps, too, the master or artificer who designed it. Let us suppose it is an old and artistically constructed cabinet. The particular stages in the observation may, of course, reach different degrees of completeness. We shall here specify those which are psychologically necessary if the purpose of the observation is to be attained. *1.* We approach the observed object with a definite purpose or goal-idea, which plays the part of a guiding idea or of a dominant point of view in the observation; thus in our illustration the purpose is to determine the style, etc., of the cabinet. The goal-idea may be definite or indefinite; it may assume the form of a general concept or of a wholly concrete particular idea. At the beginning of the observation we have the goal before us in a somewhat general fashion; but the farther the observation proceeds in dealing with the details of the cabinet, the more do we make use of definite, particular goals of observation. Hence, as a rule, we have a general, abstract goal-idea at the outset of our observation; but it gradually gives place, during the course of the observation, to a more and more definite and logically subordinate goal-idea. *2.* The object acts upon the retina as a group of visual stimuli,—in this case the color and the form of the cabinet,—and gives us, at first, a total and but slightly analyzed impression of the object. Not all of these stimuli, however, have the same effect upon consciousness because our attitude of internal predisposition and attention toward all of them is not identical and uniform; on the contrary, the stimulus which corresponds with our goal-idea comes most clearly to consciousness and is most especially noted.

3. In consequence of this, the goal-idea directs our attention to particular parts of the object toward which we turn our regard. In our illustration, it is those parts in which the character of the style is most prominent which are selected, for example, it may be the ornamentation of the cabinet.

4. Since our attention is concentrated upon particular partial impressions these are especially accentuated for consciousness, and, to some extent, isolated or raised into prominence from their surroundings, while at the same time such partial impressions as do not correspond with the view-point of observation are overlooked or remain unheeded. At the same time the will to imprint upon memory is directed upon those impressions which correspond with the goal-idea. Or more strictly speaking, the will to imprint was already present in the predisposition to observe as a will to note and imprint everything in the object which corresponds with the goal-idea; and the impressions corresponding to the goal-idea now participate in this predisposing will.

5. This brings it about that a certain selection is made among the reproduced ideas which are aroused in consciousness by the sight of the object. Those impressions which are especially emphasized by attention arouse more definite ideas than those to which we do not attend.

6. Among the ideas which are aroused by the sight of the object and the activity of attention, two sorts must be sharply distinguished from one another. The one serves exclusively for the cognition, recognition, interpretation and identification of what is given us in perception. These fuse immediately with the sense-impressions to form a unitary whole, and thereby give rise, now for the first time, to a unitary perception of the external object,—the cabinet in our illustration. They are, therefore, the ideas by means of which the fundamental forms in the cabinet are cognized, interpreted and

identified. The other ideas do not fuse directly with the given impression, but they remain free and independently reproduced ideas of memory and imagination, and persist in consciousness side by side with the impression. They are, for instance, remembrances of my formerly having seen similar cabinets, ideas of the price or value of the cabinet, and the like. *7*. This introduces a two-fold process: *a*. an analytic sensing of the object, and *b*. an internal elaboration of the impressions received. The analytic sensing of the object comes about α. as a result of our several repetitions of the process described,—our eyes and our attention wander over the whole object, point by point, in the various stages of our observation, and again and again we analyze its parts and their properties from the prevailing points of view of observation; and β. as a result of our clarifying and emphasizing now one part, now another part, by means of attention. Thus as our observation progresses, we gradually analyze the whole object from the prevailing points of view.

The completeness and accuracy of the observation obviously depends, in great measure, upon the completeness and the persistence and the energy with which these repeated acts of analytic sensing are accomplished. Our internal elaboration of the impression begins with the independent ideas of memory and imagination, or with ideas which are aroused or reproduced in us by the sight of the object. From these ideas our elaboration of the impression takes its start. On the one hand, we bring what we have just seen into relation with our previous knowledge of the various periods in the history of art; but, on the other hand, we also determine clearly what novel and characteristic features are present in the object before us, and bring them to consciousness as something which is new and characteristic. We find, for example, that not only are the familiar forms of the style of the Baroco period

represented in the cabinet, but also that the individuality of a particular city,—Danzig, for instance,—is stamped upon it. Of course, every result of our observation, not only the total result, but also the results of the various steps taken in analytic vision, may itself be raised in turn to become a new view-point of observation.

8. As a rule, we combine more or less systematically and completely into a total picture, what we discover from our analysis of the object; and this composite picture can then express the result of observation in a synthetic judgment, (synthetic activity of observation). Thus in our illustration we synthesize the results of our observation into the final judgment: "The cabinet dates from a particular period of the Baroco era, and it was constructed in the city of Danzig, etc."

It is important to note that mere persistent looking, listening, etc., *i.e.*, the persistence and the energy with which the purely sensory process of observing is accomplished,—in our case the purely visual fixation and the visual examination of the cabinet,—is of great significance for the success of observation. The English æsthetician, Ruskin, and the German physicist, Lichtenberg, stated that it was chiefly to their training in persistent fixation that they owed the "analytic power" of their observation.

In observational noting, then, one imprints upon memory the data which are acquired through observation,—not merely the total impression, but also the particular details which are determined during the process of observing. But it is clear that the work of memory depends, in great measure, upon the manner in which the act of observing has been done; we can, of course, remember only what we have observed. And, too, our method of observing may be favorable or unfavorable for retention. There are two groups of conditions upon

which success in observation depends: those conditions which have to do with the technique of observation itself; and those conditions which are especially significant for the remembering of impressions which have been acquired by means of observation.

Since observational noting depends upon the manner in which the observing itself is done, a technique or an economy of observational noting must be, at the same time, a technique or economy of observation, and a technique or economy of the retention of observed impressions. The development of an accurate method of observation ensures the survival in memory of reproducible traces of sense-impressions; and this is a preliminary condition which must be fulfilled if observational noting is to be successful. The second group of conditions concerns the specific factors of retention and reproduction. In a word, we must fulfil certain conditions of retention as well as of observation if we are to succeed in imprinting the contents of sense-perception adequately. These two groups of conditions must now be discussed more fully.

Let us first consider all those conditions of observational noting which are concerned in the technique of observation itself. Here it must be borne in mind at the outset that an observation imposes wholly different conditions and demands upon the observer according to the variable external circumstances under which it takes place. Three chief cases may be distinguished: *1.* The case where we observe a resting object which we are able to examine at leisure, and whose nature is such as to make it possible for us to bring the object under the most favorable conditions for observation,—for instance, the critical examination of a plant, or a physical or mechanical model. *2.* A second case is that in which the observed object can be seen for only an instant, and where the observation must be brief and transient. This happens

when we are called upon to observe rapidly moving objects which appear in the field of vision for only a short time; or when stimuli are present to observation for only an instant, as when we hear a momentary tone or noise, or see an instantaneous flash of light. 3. A third case occurs when objects can not be brought under favorable internal or external conditions of observation. Illustrations of this case are furnished by those objects which we can examine only from such a great distance that the retinal image can not be made clear or intensive. From these three cases which we have distinguished upon the basis of external conditions of observation, there may be differentiated three other cases which are distinguished by differences in internal conditions of observation.

In the first place, we find it possible in certain cases to bring about a careful mental preparation and hence to enter upon our act of observing with definite expectations, or goal-ideas. We shall call this a case of *inquiring observation.* It is characterized by the fact that the whole process of observation takes place under the influence of more or less definitely conscious goal-ideas or points of view of observation. At the same time, it is always a voluntary, and even an arbitrary observation; we set out to observe the object with a perfectly definite purpose in view. Secondly, the observation may be *involuntary* or *forced.* This is always the case when a stimulus makes its appearance suddenly and attracts our attention involuntarily without our having an opportunity for internal preparation. This sort of observation is characterized by the fact that its starting-point is not an expectation-idea or goal-idea which we have set up before us; it is always entered upon without such a preparation. Every involuntary observation of this sort contains an element of surprise. When upon a forest-path a bird suddenly takes flight and attracts

my attention, I am forced to an involuntary observation. The inherent difficulty of involuntary observation is due to the two characteristics which have been mentioned: a predisposing of consciousness by means of the setting-up of a goal-idea is lacking; and the observation is always attended by the emotion of surprise, which constitutes a disturbing factor. Thirdly, from these two cases must be distinguished a third possibility which has been too little heeded by psychologists. This I shall call *passively expectant observation.*[1] In this type of observation we rid ourselves of definite viewpoints of observation, and have before us only the general indefinite purpose of observing whatever may happen. We find ourselves in this condition of passive observation when we travel in a foreign country. We do not know what sort of stimuli will fall upon our sense-organs; but we propose to make a careful observation of every interesting feature in our environment. In such a case as this, predisposition by means of definite goal-ideas is wholly impossible, and would be disadvantageous because it would tend to cause us to observe certain phenomena in a one-sided and partisan fashion, while other phenomena would be overlooked. The only goal-idea which we have before us in this case is our intent to assume the general attitude of an observer.

All three of these types of observation may be made more clear by referring to the different attitudes or adjustments of

[1] This third type of observation is called '*abwartende Beobachtung.*' Here the observer does not know in advance what he is about to observe; he simply proposes to be on the alert, and to discover in good time what it will be. His attitude is one of disinterested curiosity; he is passive, calm, non-partisan and attentive. This third type of observation differs from the first type in that the observer approaches the observation without any definite predisposition, and from the second type in that he may now take his time, indeed he awaits the observation. It is then a passive, leisurely observation. *Tr.*

attention which precede the act of observing in the several instances. In inquiring observation, the attitude of attention is relatively definite, at least it prepares the observer for a particular sort of stimulus; and under certain circumstances, it even predisposes him for a perfectly definite, particular, concrete impression. In involuntary observation or observation which is taken by surprise, the attention is either not concentrated upon the in-coming stimulus at all, or is concentrated there only by sheer accident. In passively expectant observation, we adjust ourselves only for observation in general, intentionally refraining from any special adjustment; while in inquiring observation we always adjust ourselves for observation as accurately and as definitely as we can.

Now it is clear that the various sorts of internal and external conditions which we have employed as a basis for the differentiation of the various types of observation may combine in different manners. In most cases, inquiring or voluntary observation can deal only with resting objects which we are able to place under most favorable conditions for observing; at least in this sort of observation we usually endeavor to bring about this state of affairs. Nevertheless, it is advantageous to distinguish these cases from one another, and to consider rules for the technique of observation from the point of view of external conditions, and from the point of view of the type of observation which these conditions bring about.

There are, however, certain internal conditions and especially certain external conditions which are common to all types of observation; and these play a part in every act of observation. These general or common conditions of all observation are in part, external or objective, in part, internal or subjective.

a. External Conditions of Observation

1. Objects must be presented to our senses under favorable conditions if our observation of them is to be accurate and complete; thus, visual objects must be well within the range of vision, and they must appear in favorable illumination; tones and noises must be distinctly audible, etc. In controlling the external conditions of stimulation we must exclude all distractions which might impair the action of the stimuli; thus auditory observations should be made only in a quiet room, and with proper precautions as to the conduction and reflection of sound, etc. The detailed discussion of these external conditions is, of course, not a matter for the psychologist to deal with, since they concern the physiological and physical aspects of observation.

2. Precautions must be taken to adapt the sense-organs to the nature of the stimulus, if they are not already in an appropriate condition of adaptation. Thus in visual observation we must see to it that the eye is properly accommodated to the visual object, and that it is completely adapted to the brightness of the environment; the auxiliary apparatus of attention and sense-perception must also be brought into an optimal condition. For example, the eye must be made capable of accurately fixating the object to be observed, and of maintaining the fixation,—a result which is not always easily attainable when moving objects are to be observed. The whole bodily posture of the observer must be as well adapted as possible to the circumstances of the observation.

3. A further general condition of accurate observation has to do with the acuity of the sensory apparatus itself, or more strictly speaking, with the sensory acuity and the physiological sensitivity of the peripheral and central nervous mechanism. This has an extremely important bearing upon the result of observation.

4. There are certain other conditions of observation upon which depend its accuracy and its scientific value. Hence we may call these the conditions which have to do with methods of procedure in observing. Here belong, first and foremost, the facts that observations should be made repeatedly and under as nearly as possible identical conditions both internal and external; that observations should be controlled and confirmed by other observers; that the results should, so far as possible, be expressed in definite quantitative terms. The significance of these requirements, however, is logical and methodological rather than psychological.

b. Internal or Subjective Conditions of Observation

In a discussion of the subjective conditions of observation we must refer back to the three chief types of observation which have been differentiated: inquiring or voluntary, startled or involuntary, and passively expectant. Each of these types of observation has its own peculiar subjective conditions. Let us first take the case of voluntary or inquiring observation; and let us suppose that we are concerned with a resting object which we may observe at our leisure. It is in such cases as this that training in observing and noting can most readily be acquired.

Observing here begins with an internal setting-up of expectation-ideas or goal-ideas or points of view, which conduct the observation along particular paths and prepare the way for the selection of that which is to be observed, although they by no means finally determine the selection. Hence as a first condition of this sort of observation it is to be demanded that the observer shall proceed with definite goal-ideas or points of view. Moreover, these must be adapted to the purpose of the observation, and to the particular stages in the progress of the observation. They may accordingly have more of the character of general concepts or they may have

the character of concrete ideas. As points of view of observation, general concepts are especially significant when the general goal of a whole series of observations is to be stated or internally set up. For instance, when the teacher makes use of concrete objects he prescribes the analysis of the objects as the goal of observation; and he presents this goal to his pupils in the form of a general concept (phanerogam, cryptogam, etc.). But so soon as the observation is accomplished, attention is directed more and more to detailed points which correspond to the observed goal; and now to the general concept of the goal may be added more definite and more concrete goal-ideas which the observation proceeds to follow in detail. But more concrete view-points of observation, which are ideated in as definite form as possible, have a significance even when a particular and wholly definite content of perception is to be found or distinguished by means of the observation; for instance, a particular color, brightness, form, etc. Meanwhile it may be seen that the significance of the goal-idea varies greatly with the sort of material observed. The guiding ideas increase in significance with increase in the complexity of the material to be observed, because when the material contains many details there is a greater possibility that the observation will fail to concentrate, and will, therefore, dissipate its energy. When, on the other hand, the observation is concerned simply with the quality of a particular color, the directing idea has much less significance. It points out the general direction which attention, and with it regard, is sure to follow; and its task is then accomplished because of the simplicity of the visual object dealt with. Attention must now accentuate the observed content, and make it clear and distinct for consciousness.

Much more important are the conditions of observation which have to do with the proper employment of the direct-

ing idea. During observation, the attention must be fixed upon the goal idea or the view-point of observation; by this means a constant direction of attention is assured. When the attention is not thus fixated and held, the goal is readily lost sight of by the observer; the attention wanders to other objects, and there ensues a distracted or purposeless observation, although a goal of observation may have been set up at the outset. It is essential, furthermore, that goal-ideas should enter into proper relations with the objects of observation. This was already demanded, in part, by a condition discussed in the foregoing which specified that goal-ideas should not be suppressed by incoming impressions; nor should the former stifle the latter. The observer is to be on his guard lest he interpolate subjective additions into his objectively presented data; and he should always be ready to modify and correct his expectation-ideas to conform with his objective findings. When he deals with simple and easily observable objects or with objects which possess conspicuous characteristics, his tendency toward subjective falsification is not so great; investigations of the psychology of testimony show that this tendency is much less evident in observation than in memory. The danger of illusory observation is great in proportion as the object observed is complex, and in proportion as the impressions received from it are vague and indefinite, whether as a result of hasty observation, or in consequence of the character of the contents themselves,—as when we observe in faint illumination or from a great distance.

The proper relation between the expectation-idea and the objective datum determines, in part, the objective and facsimile character of observation; but only in part, as we shall see. The more we subordinate the expectation-idea to the external impression, the more objective and accurate is the observation. The less critical is our attitude in allowing this

idea to fuse with the impression, the greater is the danger that expectation-ideas which do not correspond with sensory impressions will assimilate with the latter, and the more subjective and false may the observation become.

A second condition of this type of observation is furnished by the circumstance that the goal-idea oftentimes determines the point of view from which the data are subsequently arranged and classified. This is especially likely to occur in cases where the goal-ideas refer to a general abstract goal, and where the result of the observation conforms with the goal.

But it may happen even in a simple concrete perception. Let us suppose that two colors are to be compared in order to determine their relative brightness. The goal-idea is the brightness difference of the two colors; the result of the observation consists in the perception of a greater brightness in one of the colors. Thus the goal-idea stands, in a certain sense, both at the beginning and at the end of the observation. But if the observation reaches a result which is at variance with the expectation-idea we incorporate the result into a judgment that our finding belongs not to the goal-idea but to another category.

From this it follows that the result of the observation must always relate in some way to the dominating point of view of the observation, either positively or negatively, either in a confirmative, corrective or supplementing fashion, if the observation is to be made in a systematic fashion.

Attention performs a four-fold function in the process of observation; and a systematic observation must, therefore, fulfil four conditions in so far as the behavior of attention is concerned. *1*. The attention fixes in consciousness the goal-idea or the view-point of observation; and by this means, not only does it determine the selection of what shall be observed and what shall not be observed, but it also causes

the whole observation to center, in a certain sense, about this one goal; and it sends us back to the goal again after each successive step in the observation. It is chiefly to this fixative influence of attention that observation owes its unitary character. *2.* Attention raises the observed datum in the impression to greater clearness and to a higher degree of awareness; and by this means it separates the observed content from its environment. The content is thereby isolated and accentuated for consciousness, and at the same time everything which is not to be heeded is inhibited. *3.* By this means attention facilitates the reproduction of those ideas which are directly aroused by the impression itself, which have to do with the apprehension and the interpretation of the impression, and which fuse completely with it. *4.* This function of attention brings it about that not only do the observed contents surge forward into consciousness, and not only do they arouse the idea which is assimilated with them, but they determine the selection of those independently reproduced ideas which can attach to the perception; and at the same time the formation of associations between them and the perception-content is facilitated, and the memorial noting of the perception-content is aided and reinforced.

The success of every mental activity, including the act of observing, depends not only upon the accomplishment of the component activities, but chiefly upon the co-operation of will. Will determines how much energy and persistence shall be devoted to the act of observing; and upon these two factors depends the most important result of the observation, namely, the complete and thorough analysis of the objective datum. But even the fulfilment of all of these conditions of observation does not constitute the really complete observation of an object. The most essential thing of all is the number of steps in observation, or the repetition and continuation

of the act of observing until the object is completely and exhaustively analyzed from the point of view which is, for the moment, dominant. Not until we have gone over the object, part by part, from the point of view which is momentarily dominant do we obtain a genuine analysis which renders us perfectly familiar with all of its attributes and characteristics which appertain to that point of view of observation. This completeness of observation is therefore a product of the persistence and tenacity of our will to observe; it is not a mere matter of concentration as such. From the testimony of persons who are distinguished by a supra-normal capacity of analytical observation we learn that they owe their success to this property of will,—to their persistence and tenacity in observation. Thus the physicist Lichtenberg reports that he has often forced himself to fix his eyes upon an object until he discovers some particular characteristic of interest; Ruskin relates that he had trained himself from his youth to analyze the most insignificant objects with extreme accuracy and persistence by means of long-continued gazing. Goethe's gift of observation consisted in a disposition to consider things thoroughly from the most diverse points of view. Here, then, a great significance attaches to the purely sensory acts of merely looking, listening, and the like.

General psychological reflection can not show exhaustively what significance attaches to the view-point of observation. We must discover it from an appeal to experiments which deal with the results of observation. These show us that a systematic and methodical observation is attained chiefly by having a great number and variety of view-points or categories of observation, and by knowing how to employ them in a systematic and methodical manner. This appears with especial clearness from psychological experiments which deal with the development of observation through the years of

childhood. From these we find that children in their earlier years, at the age of about seven or eight years, still fail to observe much that the adult sees, because appropriate points of view from which to observe are lacking in children. But we also find that certain adults although possessed of these points of view still fail to observe accurately because they do not make a systematic use of their view-points.[1] A further question arises as to whether the distinctness and concreteness of the goal-idea exerts any considerable influence upon observation. It is to be expected that only those persons who understand their points of view correctly can employ them correctly in observation. Hence children are able to observe only from those view-points which are adapted to their stage of mental development. But apart from this, the distinctness of the goal-idea does not seem to be of great significance because the attention may be attracted in a particular direction by indistinct goal-ideas, and indeed, often is so attracted by extremely vague expectations; and the more accurate discovery of the direction of attention is facilitated by the perception-content itself. If a person who has had no experience in psychological observation is asked to determine the relative brightness of different colors, his attention will be guided by the sensory content itself to that which is to be observed.

From all of these considerations we see that the conditions of a perfect inquiring observation are manifold. They may, however, be classified into three chief groups: *1*. The goal-idea and its proper employment; *2*. The function of attention; and *3*. The participation of will in the attainment of the observed goal. We shall later deal with the effect of observation upon retention; and then we shall return to discuss the significance of these three groups.

[1] See Chapter II. 2 c.

If now we pass on to the second case, in which inquiring observation is called upon to employ itself not with a resting object, but with an object which suddenly appears to view and as suddenly disappears, we find that here we are dealing with conditions of observation which differ radically from those already described. In this case, we must train ourselves to obtain in an exceedingly brief time as definite an idea as possible from a fleeting impression. Let us suppose that we wish to observe the particular movements and the successive postures of a horse which passes rapidly across the field of vision. The chief conditions which are here essential to success are: *a.* We must learn how to direct our sensory apparatus upon the moving object with rapidity and precision. If it is a question of apprehending an instantaneous stimulus, such as a momentary flash of light or a word or picture which is exposed for only a instant, we must learn to fixate some appropriate point rapidly and precisely and to hold our fixation at the right instant. *b.* We must be able to make a rapid adjustment of attention to the stimulus, and, in passing, to sweep the attention over the stimulus for a brief time with a high degree of concentration. *c.* Of special importance here is the state of preparation with which we enter upon the act of observing. This must not only consist in our obtaining a clear idea of the view-point of observation, but we must endeavor, so far as possible, to form a definite idea of all the minute circumstances under which the object appears, and, if possible, of the object itself. This latter operation is particularly important when the object to be observed appears only for an instant, and appears unexpectedly.

It is of advantage if we can accurately predict the moment at which the object will make its appearance; and hence in psychological experimentation a more accurate observation is secured if the appearance of the stimulus is preceded by

a signal to attention. Nor is the duration of this period of internal preparation a matter of indifference. If it lasts too long the concentration of attention flags; and if it is too brief the attention cannot rise to an optimal degree of concentration. The effect of anticipatory preparation is probably a very complex matter; it is usually regarded as consisting in a reinforcement of the external stimulus which impinges upon the sense-organ, and of the nervous excitation which is thence transmitted to the cortex,—the reinforcement in turn consisting in a process of facilitation or clearing the way (attentional facilitation, according to Exner; centro-sensory reinforcement, according to G. E. Müller). In cases of very brief stimulation, it is important that in the formation of the idea we should utilize not only the primary impression, which continues so long as the stimulus acts upon the sense-organ, but also its immediate after-effect in consciousness. Visual observations reveal the presence of a true after-image of the stimulus which may, under certain circumstances, be perceived distinctly with closed eyes, and which may be made use of in reconstructing the impression. But besides this unitary after-image, every impression is characterized by a gradual fading from consciousness; and this stage of fading, during which many of the concrete details of the impression disappear, we can learn to make use of systematically. Another important condition consists in the fact that immediately after the observation is ended, and while the after-effect of the primary stimulation still persists in some degree, we are able to give a complete account of what we have observed, and indeed, we can sometimes depict the details in a graphic sketch.

It may be mentioned here that all of these conditions of observation assume that the observer possesses certain capacities which may readily be developed and perfected by prac-

tice. Thus, in the present type of observation, it is easy to devise exercises to provide training in fixating stimuli which appear suddenly, in following moving objects by movements of the eye, in adjusting the attention to instantaneous stimuli, and in describing what has been perceived. And these exercises also furnish an opportunity for us to train and develop all of the component functions which play a part in the observation of instantaneous impressions.

The next type deals with surprised or involuntary observation. This is characterized by the fact that the initial stage of the process of observation does not here consist in an expectation-idea or a goal-idea upon which our attention is directed, but that the action of the stimulus upon our sense-organs constitutes the initial step in the act of observing. Consequently it is an observation in which internal preparation is lacking; and everything which, in the former case of inquiring observation, is accomplished by means of subjective preparation must here be accomplished during the process of observation itself if a definite result is to be obtained. In involuntary or startled observation, then, antecedent reinforcement is lacking; and this lack accounts for the absence of arbitrariness because the arbitrary character of an observation is due to our anticipating the purpose of the observation, and to our bringing about the observation by an act of will in consequence of our goal-idea. Surprised observation has, therefore, a passive and involuntary character. We do not bring it about of our own initiative; it is initiated by external stimuli which force themselves upon our consciousness. Since surprise or even fright is present in most cases of involuntary observation, it is a difficult observation to make. The success of such an observation depends chiefly upon two circumstances, a subjective and an objective: *a.* The rapidity with which we succeed in fulfilling all of

the subjective conditions of observation,—the adjustment of attention, the attainment of a definite point of view from which to observe, the adaptation and accommodation of the sense-organ to the object. *b.* It also depends upon whether the phenomenon which surprises us and attracts our attention remains within the range of observation, or whether it soon disappears again. If during a walk, I am impelled to observe a bird by its suddenly appearing before me and attracting my attention, and if the bird soon vanishes from my field of vision, the success of the observation depends upon a fulfilment of the subjective conditions which have been described. But if the bird perches upon a near-by tree, my surprised, involuntary observation gives way to an observation of the inquiring, voluntary type.

It is conceivable that training in involuntary observation may be acquired; but practice is more difficult to obtain here than in inquiring observation. It is to be recommended that training of this sort be not attempted in the school-room; pupils may be taken out for walks where every opportunity which presents itself, as when moving objects suddenly come into view, should be utilized. Practice in involuntary observation may be conceived to consist in making the transition to the voluntary type of observing as abruptly as possible. The more rapidly we overcome the surprise and fulfil all the conditions for inquiring observation,—rid ourselves of former thoughts, adapt our attention rapidly to the new impression, fix our eyes upon the object, and the like,—the more rapidly do we succeed in making the observation.

It is clear that in involuntary observation the attention has another very special function to perform, namely, to disengage itself abruptly from the thoughts which occupied it up to that time; and we know from the psychology of attention that this disengagement from previous concerns is

rendered difficult by the phenomenon which is commonly referred to as adjustment (*Einstellung*).

When we have been occupied for a time with any activity, our attention becomes adjusted to that activity, and we acquire a tendency to continue in the same direction;—or, negatively expressed, it becomes difficult to turn from this activity and pass over to any other. Hence the abrupt transition to involuntary observation, in cases where stimuli come to us suddenly and surprise us, presupposes the capacity to make a rapid change in the adjustment of attention. That means, however, that the attention must be able not only to disengage itself abruptly from its former stimuli or from thoughts which are dominantly before it, but also to adapt itself to new stimuli. It is possible then, to prepare for this sort of observing by acquiring practice in rapidly shifting the adjustment of attention, or by training in abrupt transition from one activity to another.

The present type of involuntary observation manifests still another characteristic; and we find that this one is more difficult to turn to account pedagogically than those characteristics which have already been described. Since subjective preparation is lacking in involuntary observation, the external stimulus itself not only arouses those apperceiving ideas which fuse with the impressions, but at the same time it furnishes the points of view from which the observation is made. The view-points come into being only during the act of observing itself, but in most cases, definite points of view are wholly lacking in involuntary observation; indeed, it undoubtedly happens in numerous instances that they are not constituted until later, when, after the event, we proceed to work over or to elaborate a fleeting impression which has come upon us unexpectedly. Consequently, what we shall observe and what we shall note in this type of observation

is largely a matter of chance. In such cases our habitual associations,—our habitual modes of interpreting sense-impressions in terms of familiar ideas,—must naturally predominate; that is, those ideas which are usually associated with the impressions must assert themselves with special vigor. And it is therefore to be expected that in cases of involuntary observation we should be much more likely to confine ourselves to familiar views of things than to notice strange and novel features in the perceived object.

We shall later learn, from experimental investigations, to what extent our sense-impressions are suppressed by our customary ideas. This cannot be determined by reflection alone. It might turn out, for example, that customary ideas will assert themselves less vigorously simply because the involuntary observation of a momentary stimulus arouses the activity of attention more intensively than does the inquiring observation of resting objects which we may examine so long as we please.

Less well-known and less heeded in psychology is the type of expectant observation; and yet it is probably of paramount importance for our mental life. Our attitude of subjective predisposition toward a phenomenon may be of such a sort that we intend to observe only in a general way, or to observe anything that may happen, without setting up a goal-idea. Indeed, we do not even need to think of any particular group of phenomena as the goal of our observation. This is an attitude which we frequently assume during our travels in foreign countries because we do not know in advance what novel or interesting experiences we shall encounter. In this case, no definite goal-idea or view-point is present; it is our intention only to be prepared for observation in general. The auxiliary apparatus of observation comes into action only in a very diffuse and general fashion; we allow the eyes to

wander about, although we are accustomed to fixate them upon something. We listen, but we do not listen for sounds from any particular part of our environment, etc. This type of expectant observing seems to be characteristic of certain individuals, while others cultivate the distinctive type of inquiring observation. It is said of Goethe, for instance, that he had developed his expectant observation in the highest degree. This sort of observation is especially well adapted to obviate all tension and excitation during the process of observing, while inquiring observation is never free from expectant tension and internal excitation. For this very reason, expectant observation is particularly capable of securing objectively valid results; and this characteristic is intensified by the fact that the observer does not make use of any definite point of view or expectation-idea whose employment might falsify his objective impression. Expectant observation is, therefore, particularly advantageous when we are in the presence of wholly novel and unfamiliar phenomena and do not yet know what they may present to us. The manner in which expectation-ideas and points of view become effective in this type of observation brings it into intimate relation, in certain respects, with involuntary observation. In both cases, the particular point of view must be furnished during the act of observation itself, and must be a product exclusively of the external stimulus; while in inquiring observation the point of view is only partially developed during the act of observing.

Passively expectant observation might also be perfected by practice. Its chief conditions are: *a.* The observer must hold himself free from definite expectation-ideas; but he must be in a receptive mood for external stimuli, and he must assume an energetic attitude toward the act of observing. *b.* He must be capable of obtaining the proper points of view from the objectively given data, during the act of observing;

and these points of view enable him to distinguish that which is novel and peculiar from that which is familiar and customary.

Now it is evident that each of the above conditions of accurate observing, in its various possible forms, is at the time an important pre-condition and pre-supposition of observational noting, because, of course, we are able to note only what we have observed clearly, and we retain impressions more readily in proportion as we have fulfilled the conditions of accurate, objective, complete and distinct observation.

But our procedure in observing may be such that it fulfils certain conditions which are specifically concerned in the retention and subsequent reproduction of impressions. And these may be stated, in part, from a general consideration of memory for sensory data, but in part they must be derived from experiments in observational noting. The general conditions which are derived from the nature of noting itself may be formulated first, in order that we may explain them more fully later, in the light of experimental data. The most important and most general condition is that the observation must, as a matter of course, be carried on from the outset with the deliberate intention not of grasping the impressions merely for the moment, but of retaining them permanently. This directing influence of will and of subjective attitude during the act of observing determines, in general, the effect of observation upon memory. If we have the will to imprint the observed data upon memory in order that we might subsequently be able to reproduce them, we actually retain them more readily; and when the will to remember is lacking, the incorporation into memory fails to take place, or if it does occur, it is a matter of sheer accident. This is probably to be explained from the fact that, when the will to remember is present, we assume a somewhat different attitude toward

the observation. In the first place, we dwell upon the impressions longer than is necessary for mere apprehension; and we can sometimes notice here that we observe the impressions individually and discretely. It is especially to be noted that we designate them by names, and we concentrate the attention upon them more accurately. Secondly, we make a stronger effort to bring them into relation with one another, as when in imprinting a landscape upon memory we note carefully the relative sizes, distances and directions of its parts, and subsequently employ these spatial relations to reinforce memory. When it is our purpose to remember we search more for connections among all of the individual impressions in order by this means to secure more secondary aids for memory. It is probable, too, that the will to remember reacts upon attention in that we endeavor to raise to greater clearness and definiteness the impressions which are to be retained.

It seems probable then that the will to remember what is being observed brings with it a characteristic attitude; and that this attitude, in turn, is especially favorable for the operation of those factors which give rise to a formation of associations among ideas. We have already seen that the most fundamental condition of association is to be found in the temporal relations of the idea. We establish particularly secure and stable associations between those impressions which have longest been present in consciousness and which have most frequently been repeated; and those ideas are most readily reproduced which have entered into numerous associative relations with one another. All three of these conditions are a product of the will to imprint the data of observation, which leads us to dwell longer upon impressions, to focus the attention upon them repeatedly, and at the same time to associate all their subsidiary impressions with them

memorially. And here again is seen the dual activity of memory: for the individual impression we create as lasting a disposition to revival as possible; and we also endeavor to connect or to associate the impressions with one another.

In imprinting objects upon memory by bringing them into associative relations with one another we fulfil yet another important condition of noting and remembering. We not only establish associative connections between objectively given data, but we also bring the data into relation with our current ideas and with our general body of knowledge. These relations are in part of a purely associative nature,—pure connections of ideas; they are, in part, of a logical sort, and consist in the ascription of relations to the impressions. These two activities furnish us with a unitary comprehension of the impressions. The more we understand objectively given data and comprehend their logical and objective relations, the more readily can we retain and reproduce them. Impressions which are something more than the elementary material of mere sensation can be retained and reproduced if they are understood in the sense described. Thus, for example, we remember the lines of a drawing, or the outline of an object only when we have understood the principles embodied in their construction. No one is able to remember an arabesque from the purely visual picture as such without getting clearly before his mind the plan of its design and the principle of its construction.

This is true also of the temporal relations of impressions. They, too, are a chief aid to memory because they bring to consciousness the temporal arrangement of the impressions, indicating which of the events occurred earlier and which later, and showing in how far certain processes occurred simultaneously, and by how long intervals of time the impressions were separated from one another.

The spatial and temporal relations of stimuli attain definiteness only when we note their quantitative relations, as spatial and temporal distances and intervals and proportions; we do not obtain a definite idea of them until we reduce them to numerical statement. The noting and estimating of quantitative relations in spatial and temporal impressions are also important aids to memory,—probably for the twofold reason that the ideas themselves are thereby made more definite, and that such a conceptual knowledge of the relations of number and magnitude combines with the remembrance and furnishes it with a secondary support.

The completeness of the analysis which is made during the process of observing is of paramount importance for the retention of impressions. It is important, in the first place, because it guards against lacunæ in memory, and by this means it lessens the danger of gaps being filled, without our being aware of the substitution, by customary associations and by imaginative adjuncts; secondly, because a complete observation gives rise to many more associations of impressions with ideas and with one another. We know, too, that those impressions which are most intimately related to emotion and to interest are most readily observed and noted. But it is impossible, by means of reflection alone, to discover any definite principle concerning what part is played by emotion in observational noting. We shall see, however, that experimental investigations have yielded interesting results bearing upon this topic.

All of these conditions of observation and of observational noting may be made clear, by general psychological considerations, from the nature of observation and of memory; but in addition to this, experimental investigation has revealed the intimate nature of observational noting from various points of view.

CHAPTER IV

OBSERVATIONAL LEARNING (*Continued*)

2. *The Experimental Investigation of Observational Noting*

Most of the experiments upon which the following discussions must be based were not undertaken for the purpose of investigating normal observational noting itself. They have dealt, in part, with a somewhat different group of psychological problems; in part, they have been undertaken by psychiatrists and psychopathologists who have been interested in pathological disturbances of memory. But the results of these investigations are available for our present purposes because they give us an insight into certain characteristics of observational noting.

It was not until recently that psychologists turned their attention to the experimental investigation of the factors which play a part in the act of observational noting. Their experiments are concerned either with the retention and reproduction of simple sensations,—especially colors and tones, and hence they may be referred to as experiments in sense-memory,—or they deal with the retention and reproduction of spatial relations and temporal relations,—in which case they may be called experiments in the memory of space and time, or in spatial and temporal estimation. We have a relatively small number of investigations of the observational noting of complex impressions, such as the noting of combinations of forms and colors; not until recently have psychologists undertaken the investigation of the retention and reproduction of complex objects. All of these experiments have yielded

results which are instructive for the student of pedagogy. We shall present a brief survey of their essential features; and then we shall summarize the conclusions which may be drawn from them, in so far as they have a bearing upon the training and the technique of observational noting.

a. Investigations of Sense-Memory

Let us first describe the methods and results of the experiments which deal with sense-memory. In tests of sense-memory we may regard the retention of a single sensation as the simplest case; then, in progressive order, the retention of a sensation-difference or a combination of sensations; then the retention of the spatial and temporal relations of sensations; and finally, the retention of complex spatial and temporal impressions. Two modes of procedure are possible in these investigations: 1. A particular stimulus may be presented to the observer,—a tone of a certain pitch and intensity, a color of a certain saturation and brightness,—and the attempt may be made to determine whether the same stimulus can be recognized after temporal intervals of variable length. This is the method of *Recognition*. Here it is necessary, of course, to employ not only the original stimulus, but also to introduce others which differ from it. The first impression is usually called the standard impression, or if referred to its objective cause, the standard stimulus; and the second is called the comparative impression or the comparative stimulus. 2. A method of *Production* or *Reproduction* may be employed. After a definite interval has elapsed the observer is here required to reproduce the standard color or the standard tone by means of an apparatus adapted to the purpose. In either case, the observer's errors may be taken as a measure of the accuracy of recognition and discrimination in the former case, and of reproduction in the latter case. The error, together

with the length of interval elapsing between stimulus and reproduction, expresses the accuracy of sense-memory. Of course, if such experiments are to give us a really accurate measurement of memory function, various precautions must be observed in the conduct of the experiments; especially is it necessary to make numerous determinations under identical conditions, internal and external, and to preserve a constancy of attention throughout. The evaluation of the results introduces numerous mathematical complications; but it seems unnecessary to discuss them here. We may in general, regard the fraction $\frac{c}{n}$ as an approximate measure of the accuracy of memory, where c is the number of correct estimations and n the total number of estimations. By a variation of time-interval (seconds, days, or weeks) we are able to extend the experiments to include both immediate and permanent retention.

Using a method of this sort, in the psychological laboratory at Leipzig in 1886, Wolfe[1] performed a series of experiments upon memory for tones, and succeeded at that early date in determining the most important characteristics of sense-memory. Wolfe's chief result,—which has been confirmed by other investigators, although the numerical data obtained by the latter may have been somewhat different in consequence of differences in experimental conditions,—may be stated as follows: The accuracy of tonal reproduction depends, in two respects, upon the length of time which has elapsed between the standard and the comparative tones. 1. The interval must not be too short, for if the comparative tone comes too soon,—within a fraction of a second after the standard tone,—it is found that consciousness has not yet finished working-over the standard tone, and comparison is thereby rendered

[1] H. K. Wolfe, Untersuchungen über das Tongedächtnis, *Philos. Studien*, III., 1886, 534ff.

difficult. It turns out that about two seconds is the time which must elapse if the observer is to make an accurate discrimination between the two tones. It is evident that immediate retention is in operation throughout in these experiments, and the investigation is rather a test of sensory discrimination than of the temporal capacity of memory,—the first sensation being still present to consciousness in the form of an after-effect when the second appears (successive comparison). 2. When the time interval exceeds two seconds, the earlier impression fades and the accuracy of reproduction and recognition decreases,—rapidly at first, then more and more slowly. With an interval of one minute, the uncertainty becomes so great that the second tone is estimated correctly in only about one-half of the cases. It turns out, too, that favorable and unfavorable lengths of time-interval alternate with one another; forgetting, therefore, does not progress in a constant and uniform fashion, but shows a series of upward and downward fluctuations. Thus, it may come about that tonal estimation is less accurate after an interval of fifteen seconds than after twenty-five seconds. These phenomena demand explanation; and two possible explanations present themselves. *a*. One might be tempted to regard the whole process of remembering and forgetting as a product of attention. Forgetting would then begin at the moment when the impression leaves the focus of consciousness; and the various periods of recognition or reproduction which are characterized by greater accuracy could be explained by correlating them with fluctuations of attention. It is a well-known fact that attention itself can not function with a constant degree of concentration even for a very brief period of time, but normally manifests fluctuations of intensity. If, now, the revival of the tone occurs at a period where favorable conditions of attention are present, the tone will be recognized or repro-

duced more accurately than when the revival coincides with a subsiding of attention. Observers themselves report this continuous alternation of waxing and waning attention. It is even possible to distinguish shorter and longer fluctuations; and both of these may be of significance for the reproduction of impressions. *b.* We might assume that the decrease of retention and the increase of forgetting are due to the gradual obliteration of the memorial dispositions themselves; and that the dispositions or traces which remain after the stimulus is gone do not become the prey of the variable behavior of attention, but themselves are subject to a general law of gradual fading with the lapse of time. In that case, the fluctuation of attention would exert only a secondary influence upon the accuracy of reproduction. In my opinion, the second hypothesis is much more probable, chiefly for the reason that a relatively accurate reproduction is possible after attention has been diverted from the impression and the stimulus has ceased to act upon consciousness. We shall later make the acquaintance of various other facts concerning the reproduction of ideas, which support this view.

Numerous other investigations, similar in form to Wolfe's, have been undertaken more recently; but no results which are essentially new in principle have been discovered. Heidenhain investigated memory for colors; Lewin, for colors and other visual stimuli; Radoslawow, memory for extents of visual space (lines and distances between points); Baldwin, Shaw and Warren, and Binet and Henri investigated the retention of lines and simple linear figures for different intervals of time. Baldwin and Shaw had their observers draw geometrical forms from memory or select them from other figures (*Recognition Method* and *Selection Method*). Binet and Henri had their observers select and recognize lines and spatial forms. Numerous other psychologists have made analogous

investigations in which temporal intervals of brief duration (one fifth of a second to five seconds, and even more) were employed as data to be remembered; in these experiments the remembered datum was either reproduced after the lapse of different periods of time, or it was compared with another interval. These experiments yielded the remarkable result that only very brief temporal intervals,—probably not more than two seconds,—are capable of being immediately perceived; that an interval of approximately half a second is most accurately retained and reproduced,—this is the average interval between steps in walking, and is for that reason an interval with whose reproduction we have most experience; and that in our reproductions we over-estimate intervals of less than one half-second, while we under-estimate intervals from one half-second to twenty-five seconds.[1]

The most important results in all of these experiments were that the progress of forgetting is rapid at the outset, and then more slow; and that, with every sort of stimulus employed, the tailing-off of the original impression is, in all probability, an irregular and fluctuating process. If we could discover the causes of these irregularities in the progress of forgetting, the nature of forgetting would no longer remain a mystery. As already mentioned, forgetting begins at the instant when the attention is turned away from the impression, for, at that instant, the impression begins to fall to a lower degree of awareness; and since it is no longer made secure in consciousness by attention, it may now be suppressed or dislodged by other impressions or ideas. Forgetting does not, however, consist solely in a distraction of attention; it probably consists in *1.* a dislodging of the forgotten impression from con-

[1] For a discussion of the striking similarity between these illusions of time and illusions of visual space see my paper in Wundt's *Philos. Studien*, IX., X., 1894.

sciousness by other impressions or ideas, and 2. in a consequent fading of its after-effect or disposition to revival because the impression is no longer present to consciousness. This weakening of the after-effect of the primary impression or of the tendency toward revival probably constitutes genuine forgetting; and the revival of the after-effects by renewed reproduction, either through the agency of a repeated stimulation or of a simple reproduction of ideas, constitutes a genuine restoration of the disposition which in turn gives rise to a permanent retention of the impression. It is the waning of the disposition which proceeds more rapidly at first, more and more slowly later; and just for this reason, the renewal or restoration of a disposition is more successful the more immediately it follows the waning of the original impression.

Experiments which have dealt with the influence of attention upon the process of noting are closely related with those which have dealt with sense-memory. They show us that the predisposing function of attention which fixes and secures a goal-idea is also subject to just such normal fluctuations as are characteristic of sense-memory. When in reaction experiments,[1] a signal is given to warn the observer that the stimulus is about to come, the length of the interval which elapses between the warning signal and the stimulus is a matter of considerable significance. It has been determined that the signal must precede the stimulus by about two seconds in order to secure an optimal condition of attention for the reception of the stimulus. Shorter intervals do not give

[1] The simple reaction experiment is arranged as follows: The observer responds to a pre-arranged stimulus by making a pre-arranged movement,—depressing a telegraph key, or the like. The time which intervenes between the application of the stimulus and the beginning of the reagent's movement is measured, and designated his "reaction-time."

sufficient time for concentrating and adjusting the attention; when the interval is longer, the concentration of attention begins to wane before the stimulus appears. We shall see that the state of preparation is of prime significance for observation and observational noting.

Even from this small group of experiments it is possible to deduce important rules for the technique of observational noting. *1.* We see that it is of advantage to recall the goal-idea to consciousness in accurate and definite form a short time before the observation begins; but care must be taken that this time is neither too long nor too short. This becomes important in cases of instantaneous stimuli, where we have but little time during the observation itself to bring the viewpoint of observation clearly to mind; for example, in our illustration of inquiring observation with abrupt and fleeting stimuli.

2. We find that all sense-impressions pass through two stages of forgetting. The first phase is to some extent only a waning of the original impression; during this period the impression can most readily be revived in accurate form, and hence it can be re-established in memory most easily by renewed observation. From this it follows that for the technique of observational noting it is advantageous to imprint stimuli accurately during the observation itself, wherever that is possible, or, in any case, immediately afterward. And this is the procedure which we involuntarily adopt whenever we wish to secure a lasting memory of complex stimuli. We repeat the observation with the intention of noting the impression while the object is still before us; or we close the eyes for a moment and later return to the object after attempting to reproduce it independently. The second stage of forgetting is of longer duration. During this period the impression, which has already faded in some degree, slowly

and gradually becomes weaker and weaker. From observations of my own learning and retention of very complex visual stimuli, such as a painting or the facade of a building, I have determined that the first period of forgetting also manifests the following characteristics: *a.* The memory-image has much more freshness, and is in every way qualitatively more like its original than it is subsequently; *b.* the memory-image is here very much richer in detail than during the second period of forgetting. Hence, whenever we are called upon to remember complex impressions, it is expedient to begin a reconstruction of the memory-image as soon as possible after the disappearance of the primary impression; and wherever possible, to write down a complete description of the details because these will subsequently be lost from memory.

b. The Experimental Investigation of Observing and Noting

A chief condition of accurate observing and observational noting consists in the proper behavior of attention during the act of observing, and especially in its capacity to be distracted or to resist distraction in the presence of disturbing stimuli. In the complex function to which the name "attention" has been applied, modern psychology differentiates a variety of attributes. Individuals differ from one another in the relative prominence of particular attributes, and these variations may constitute thorough-going individual differences of attention and of total mental endowment. The attributes which are most important for our present purposes are intensity of concentration, and inhibition of distractions. These constitute the basis of individual capacity to concentrate and its opposite,—individual tendency to succumb to distraction. Experimental psychology has endeavored to measure these capacities in the hope of discovering a means of measuring attention. One of the most reliable methods consists in

having the individual perform rival mental acts simultaneously. In the simplest case, the attention is attracted in several directions at the same time by rival stimuli, and we endeavor to observe the change in sensory impression which results. A somewhat more complex case occurs when we endeavor to carry on several activities simultaneously. By this means, capacity to concentrate is measured directly, and tendency to suffer distraction is measured indirectly when we determine the amount of decrease of mental efficiency which results from the introduction of rival impressions or activities. Kraepelin holds that distractibility and capacity to resist distraction can themselves be measured by the introduction of temporary or permanent distractions while mental work is being done.

Since the attention may become accustomed or adapted to distracting stimuli, Kraepelin believes that continuous distractions enable us to measure the individual's adaptation capacity. A great many investigations dealing with this problem have been carried on in the Cornell laboratory under the direction of Professor E. B. Titchener. In these experiments, impressions of various sorts were subjected to distracting influences, the object of the investigation being to determine what is the effect of the distractions. These experiments show that it is very difficult to divert the attention by means of distracting stimuli. Three cases must be distinguished: *1.* Unless an actual distraction takes place an external stimulus does not necessarily disturb the attention at all, either in the sense of diverting it from the activity upon which it is engaged or in the sense of impairing its functional activity. In this case, the tendency to distraction is overcome by an increased concentration of attention; and one may either completely conpensate the distracting influence or one may more than compensate it, *i.e.*, the concentration of atten-

tion may increase to such an extent that not only is distraction avoided but the original efficiency of attention is actually increased. 2. The disturbing stimulus may not really distract the attention but still may interfere with its function because the observer is obliged to concentrate too intensively if he is to maintain a uniform degree of attention in the presence of the distraction. Here the energy of attention is diminished, but the attention is not diverted from the work in hand. 3. The attention may really be distracted; it may turn and occupy itself with the disturbing stimulus, or it may turn to some other objective point, in which case an essential impairment of its function or indeed a complete interruption of its original activity may be expected to ensue.

The Cornell experiments show that different individuals conduct themselves differently in the presence of a distraction of the attention. For example, certain observers pause in their adding when a distracting stimulus is introduced, and during the pause a definite awareness of the distracting stimulus comes abruptly to consciousness; others, on the contrary, can not be so interrupted. In the latter case, one finds that the observer is but dimly aware of the disturbing stimulus; in certain instances he is not aware of it at all.

In these experiments, concentration is measured by the simultaneous performance of homogeneous activities. Other investigators have had recourse to the simultaneous performance of heterogeneous activities, and have measured concentration from the cessation of these activities (Binet and Henri, Paulhan, Sharp). For instance, one is asked to read and to write at the same time, or to read and to draw a continuous spiral, and the like.[1]

[1] E. B. Titchener, *Lectures on the Elementary Psychology of Feeling and Attention*, New York, 1908. A. Binet, La concurrence des états psychiques, *Rev. phil.* XXIX., 1890. F. Paulhan, La simultaneite des

Other experiments have investigated the influence exerted by distracting stimuli upon motor reactions or upon simple movements such as are made in beating time. Swift found that homogeneous stimuli have a greater distracting power than heterogeneous stimuli,—when visual stimuli are introduced they have a more pronounced effect upon reactions to visual than to auditory stimuli.

Binet and Jastrow employed reading, adding, and other mental activities in an effort to disturb tapping movements. The amount of distraction is found to vary with the complexity of the tempo. Simple time-marking soon becomes automatic, and the movements of beating time are disturbed but little, or not at all, by the simultaneous execution of mental operations; more difficult tempos are very much disturbed, however, probably because they do not so readily become automatic but make a greater demand upon attention throughout.

These experiments bring to light two important points: the distracting influence of a secondary stimulus is probably greater in proportion as the two stimuli which are simultaneously present are similar in character; and the effect of distraction is lessened in proportion as one of the activities in question can be mechanized.

The most important experiments of this group we owe to the Kraepelin school at Heidelberg and at Munich. Vogt[1] investigated the distractibility of normal individuals, because distractibility of attention and power to resist distraction seemed to him to be a characteristic symptom of certain mental disorders. From a comparison of normal and abnormal

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actes mentales. *Rev. scientif.* XXXIX., 1887. S. E. Sharp. Individual Psychology, *Amer. Jour. of Psychol.* X., 1899.

[1] R. Vogt. Ueber Ablenkbarkeit und Gewöhnungsfähigkeit, *Kraepelin's Psychol. Arbeiten.* III., 1899, 62–201.

individuals Vogt concludes that the efficiency of attention may be estimated in terms of the pertinacity with which the individual clings to "goal-ideas" or points of view in observing and in observational noting. Upon the capacity to hold definite goal-ideas resolutely before one, depends in great measure one's capacity of concentration. "The greatest capacity of concentration is present when the more specific goals are subordinated to a more general goal." Yet Vogt is of the opinion that the power to hold fast to the goal-idea in observational noting is, in large measure, dependent upon the emotional life of the individual. On the one hand, complete indifference and disinterestedness is an impediment to the setting up of goal-ideas; but, on the other hand, the emotional life must not be subject to great variations of intensity if this capacity to concentrate the attention is to be present. The efficacy of the goal-idea is recognized by Vogt to consist in a selecting or choosing of what shall come to consciousness during the act of observing. To it is due the fact "that only those external stimuli or those ideas which accord with the direction of the goal can come to clear consciousness." The significance of the goal-idea for observing and noting will be made clearer in what follows.

Vogt also endeavored to measure the distracting influence which other processes coming to consciousness during mental activity exert upon the result of the latter. The effect of distraction was investigated in motor reactions, and in experiments upon apprehension, upon the association of ideas and upon the function of memory. The distractions consisted in the apprenhension of stimuli, in reaction movements and in memorization. For example, the observer was asked to read nonsense-syllables or to add numbers while he was engaged in tapping in unison with the beats of a metronome; and his power to resist distraction was measured in terms of the effect

which artificially introduced distractions exert upon his efficiency in the task upon which he is engaged. Distractibility is identical with susceptibility to disturbing influences; hence in measuring this susceptibility we obtain an indirect measurement of his power of concentration. Vogt believes that the simultaneous and really efficient accomplishment of two activities by means of the attention is impossible. As a matter of fact, attention never splits into two halves which then function in an identical fashion; but every simultaneous achievement of two activities is due either to one of them having become mechanized to such an extent that it demands little or no attention, or to our ability to alternate rapidly from one activity to another. Now, it would be a matter of importance if we could obtain a clearer insight into the mental procedure which takes place when we seem to do several things simultaneously because, as a matter of fact, the attention is obliged to occupy itself with different impressions at approximately the same time, in many cases of observation and of observational noting. Vogt's experiments give us information concerning certain phases of this problem.

These experiments yield numerous results which are similar to the data reported by the American and French investigators whose work has already been described. They show that the effect of the subsidiary activity varies with the nature of the chief activity which engages the attention of the observer. For instance, the execution of simple tapping or writing movements in unison with the beats of a metronome, or with the sound of a bell which is struck at every fourth beat of a metronome (beating nineteen times per minute) does not diminish one's power to apprehend nonsense syllables; nor is apprehension decreased by the act of reading certain specified letters (*e*, *n*, *u*, *s*,) from a printed page. But when the observer is required to mark these letters, a distinct dis-

traction results. The distraction is found to be but little increased when the secondary operation consists in adding pairs of numbers and recording their sum. It is considerably greater, however, when the observer is required to add continuous series of numbers,—an operation which, of course, demands a much greater concentration of attention because the various partial sums must be retained in memory. Finally the memorization of syllables and lists of numbers is impaired most of all by a subsidiary task.

There is one point, especially, in these investigations which has a special interest in connection with our general problem. In both Titchener's and Vogt's experiments, it was found that the effect of distraction is least when one is engaged in the perception of sensory stimuli,—that is, observation and observational noting are much less disturbed by secondary activities and secondary stimuli than is any other sort of mental function. Vogt expressed it as follows: "Hence we see that the processes of perception and apprehension, which are aroused by external stimuli, suffer much less from the effects of distraction than do the reaction movements which are based upon volitional processes, or less than tasks of reading and adding which are accompanied by associative and memory processes. The more demand an activity makes upon the combination of many slightly practised associations of ideas, or the more it demands the arousal of remembrances, the more susceptible is it to distraction."

It does not seem to be difficult to explain this phenomenon. During the act of observing, memory constantly receives aid from external stimuli; the turning of the eye or the ear toward the stimulus suffices for an immediate re-discovery of the point of contact with the previous activity. For this very reason we are more independent of distraction in perception than in other mental functions. This fact is of great peda-

gogical significance because it shows that concentration of attention and the important property of resistance and non-distractibility can most readily be employed in observation and in the apprehension and noting of sense-impressions. Hence a simultaneous apprehension of several impressions, or a simultaneous accomplishment of subsidiary activities while we are engaged upon the observation of a stimulus serves as an appropriate means for a formal training in the concentration of attention and in the resisting of distractions.

An additional step in the progress of our knowledge of observational noting came with the systematic investigation, by the pupils of Kraepelin, of the capacity to perceive and to note under different conditions. Finzi[1] investigated the dependence of observational noting and retention upon the sort and the amount of material presented. He also dealt with the influence of different aids to imprinting, and the influence of the time interval which elapses between the first imprinting and the reproduction; and he turned his attention chiefly to the degree of subjective assurance with which different observers give their testimony.

Finzi worked exclusively with visual stimuli, Philippe having already investigated the noting of tactual impressions.[2] Philippe blindfolded his observers and had them handle an object; then, after a definite number of hours or days, they drew pictures of the object. This method, however, is very unsatisfactory; from the results of the investigation we see only in general that the accuracy of memory-images

[1] J. Finzi. Zur Untersuchung der Auffassungsfähigkeit und Merkfähigkeit. *Kraepelin's Psychol. Arbeiten*, III., 1900, 289–384. See also J. Finzi, *Die Schwankungen der geistigen Tätigkeit*, Wiesbaden, 1903.

[2] J. Philippe. Sur les transformations des nos images mentales, *Revue philos.* XLIII., 1897, 481.

decreases with the lapse of time. Finzi employed letters, numbers and nonsense-syllables, written upon cards. These were presented by means of an apparatus devised for the purpose, the duration of the exposure being only about one-fiftieth of a second. After the exposure, the observer was asked to state what he had observed; and this was usually done after a very brief interval, either immediately after,—in this case observation was tested rather as an act of noting,—or at the end of two, four, eight or fifteen seconds, and in one series after two to five minutes. This investigation therefore also dealt essentially with the immediate fading of the impression. Finzi distinguished between experiments in apprehending and in noting. In the former, the observer's report of what he had seen was made immediately after the presentation of the numbers, letters or syllables; in the latter experiment, the reproduction was not made until after the lapse of one of the intervals just mentioned. The observers were instructed to obtain as clear an impression as possible of the object upon the card, to fixate the attention upon it, and not to allow it to escape from the focus of attention. In order to facilitate this, the observer sat silent and motionless during the interval between the presentation and the reproduction, directing his eyes throughout upon the point where the stimulus had appeared. This is a very important circumstance in the determination of the process of forgetting because a forgetting or a fading of the impression occurs even when the attention endeavors to hold fast to the remembrance of the impression.

The following excerpt from Finzi's results is important for our purposes. In measuring what an observer has accomplished, we must distinguish between the amount and the reliability of his performance. The amount of his performance is determined by the sum of all the statements which he

furnishes regarding the impressions; the reliability is calculated from the number of correct statements or their ratio to the total number. One must be careful to avoid falling into the erorr of ascribing a highly accurate sense-memory to those individuals who make a great many statements regarding what they have remembered. A much more important result is the ratio which determines the fidelity or reliability of their statements.

As regards the number of stimuli to be employed, Finzi reports that a large number is unfavorable to perception because the act of perceiving readily becomes difficult or confused in such cases; yet he finds that an increase in the number of presented data is not so disadvantageous to the function of memory. Greater differences were found in the acquisition and retention of particular sorts of impressions. Numbers are apprehended more readily than letters but they are not retained so well. Letters are apprehended and noted more readily when they appear in nonsense syllables than when they appear as isolated letters. In the investigation of noting it was found that single observations have an influence upon one another,—a phenomenon which must be regarded as especially important in associative learning. For instance, it is not advantageous to present a great many similar objects in immediate succession to the same observer; the individual impressions have a tendency, in such cases, to become confused with one another and reproduction is impaired. Apprehension or observation is less subject to this type of confusion than is memorial activity, such as reproduction.

As regards the temporal interval, Finzi found the state of affairs for his complex material to be wholly similar to that reported by the earlier investigators who had employed simple impressions. There are certain very brief intervals,—eight to thirty seconds,—for which the reproduction of impressions

is easy and certain; but even these differ somewhat in amount and in reliability of reproduction. Here again, then, we see that the best reproduction does not take place immediately after the first fading of the impressions. This proves again that forgetting is not due solely to a diverting of attention but that it is a phenomenon *sui generis*, probably identical with the fading out of the traces or dispositions left by the primary impressions. The amount of impression was greatest at the end of 6 to 30 seconds; the intensity of impression was greatest after 4 to 15 seconds. Applied practically to perception, this means that about 10 to 15 seconds should elapse after the primary impression if we wish to obtain a report which is at once ready and reliable. In teaching, we should therefore always allow pupils a certain time in which to work over the perception-content in a purely memorial fashion, and not begin to question them immediately after the act of perception has ceased. This phenomenon is closely allied with reproduction itself. The readiest answer to a question and the first ideas which occur to one when one hears a remark are least likely to be correct.[1]

Importance also attaches to Finzi's statement regarding the different means of imprinting; but these were, unfortunately, investigated without an accurate determination of the ideational types of his observers. When, as in Finzi's experiment, one is called upon to note numbers, letters or syllables, it is possible to proceed in three or four different ways. One may imprint upon memory the visual images, or the auditory and vocal-motor images, or the vocal-motor images alone. One observer endeavors to remember the visual images of the letters, another says them over to himself, another hears them in imagination, while others speak and hear them at the same

[1] E. Meumann. *Vorlesungen zur Einführung in die experimentellen Pädagogik, Zweiter Aufl.*, 1912, I., 516.

time. In general, it was found in Finzi's experiments that retention by means of visual images gives the most reliable results. This is undoubtedly due to the fact that visual images were the memory material which conformed most closely with the stimulus, for his method of presentation was visual. But it is probable that the same rule holds for observational noting as for retention in general. Every observer must, so far as possible, discover his own peculiar mode of remembering and employ chiefly that means which corresponds with his own ideational type. But the nature of the stimulus is also important. Visual stimuli are retained better by means of visual images; auditory stimuli better by means of auditory images, etc. It is probable, therefore, that the most advantageous retention is that in which the individual endeavors to reach a compromise between his own ideational type and the sort of stimulus presented to him. A visualizer will naturally be obliged to rely upon visual imagery in dealing with visual stimuli; an observer who images in auditory terms will, in such a case, endeavor to employ his feeble visual imagery so far as he can, but he will reinforce them wherever possible by means of auditory images.

Do we remember better when we rely solely upon impressions and ideas which correspond to our ideational type? Or is it more advantageous to have recourse to as many sorts of imagery as possible? Two American psychologists, Muensterberg and Bigham, have attempted to show experimentally that it is more advantageous to employ as many sorts of images as we can. Results obtained by Segal and by myself show that it is more advantageous for the observer to depend upon his own ideational type and upon the images corresponding thereto, so far as he can, and to attempt to effect a compromise between these and the modality of the presented datum only when the latter does not coincide with his ideational type.

The former occurs when a person of the visual type has to deal with visual stimuli; and the latter when he deals with auditory stimuli.

It may be added that Finzi also made a study of the distraction of attention during the act of observation which constituted the chief topic of his investigation. Attention may be distracted either while the observation is in progress (Wundt's diverting method), or after the observation has been completed (Wundt's obliteration method),—the aim being, in the latter case, to obliterate the primary impression before the act of reproduction begins. The former experiments were obviously concerned with the immediate retention of an observed datum and with the behavior of attention during the observation itself; the latter dealt with the delayed reproduction or the recognition of an impression after it had been crowded out of consciousness. We have already seen that it is extremely difficult to distract the attention, and that distraction is least effective in the case of sense-impressions. Finzi found that the effect of distraction, and its subjective compensation by the observer depend upon the means by which not only the noting, but also the distracting itself is accomplished. The observer who is accustomed to work with visual images is most distracted by subsidiary activities which also make use of visual images. The individual whose customary procedure in the act of learning consists in pronouncing the letters or syllables is distracted most when his vocal apparatus is called into play by the distracting stimulus. In general, therefore, it turns out that those distracting stimuli have the most pronounced effect which most closely resemble the impressions to be noted or the means employed by the observer in noting them.

It may be added that Finzi found that visual imagery is subject to relatively little falsification in reproduction; and

when we remember that visual learning is also most advantageous for the recognition of letters, visual noting seems to excel in every respect. Since we have to do chiefly with visual material not only in practical life but also in the school-room, it follows that visual impressions are of greatest significance for our consciousness even during the observing itself; it follows also that children should be trained, so far as possible, to employ visual imagery in noting impressions.

Concerning the subjective assurance with which individuals report their observations, it may be said in general that subjective assurance is greatest soon after the observation is completed, and that it decreases with the lapse of time. The decline of assurance is attended by characteristic phenomena, —correct statements are made with a feeling of uncertainty, and erroneous statements with a feeling of certainty. Then, too, subjective certainty manifests an individual variation. In the case of one observer, Finzi found that as many as one-third of his false statements were made with a feeling of certainty that they were correct. The feeling of certainty is therefore by no means a reliable index of the fidelity of memory,—an observation which has been confirmed by the investigations of testimony by Stern and others, and by observations in criminal psychology made by Gross and others.[1] "Even those parts of the memory-image which have been smuggled in subsequently may be accompanied by a feeling of absolute certainty." In these and numerous other experiments, it is shown that one is always inclined to supplement incomplete memory-images so that they may give the same general impression as the original phenomenon; and the addition which judgment or imagination makes to memory

[1] H. Gross. *Criminal Psychology* (trans.), Boston, 1911; Mnemotechnik im Unterbewusstsein, *Archiv f. Kriminalanthropologie*, XXIX., 1907.

can not, in many cases, be distinguished from the genuine. It is unfortunate that we do not know how the feeling of certainty originates in our remembrances. Finzi advances the hypothesis that the distinctness of the memory-image plays a leading rôle in giving rise to it,—the more distinct the image the more convinced are we of its fidelity. It is possible that certain sensations also play a part here, such as organic sensations which may produce the feeling in question. The feeling of assurance is probably most illusory "in cases where the perception itself was inaccurate, or the elapsed interval was long, and the opportunity for falsification by means of ideas, external influences and emotions was most abundant." (Finzi.)

It is, of course, important that when we train children in observational noting, we should direct their attention to the illusory character of the feeling of certainty, in order that they may soon reach the conviction that the only reliable test which we have for the accuracy of our memory of sense-impressions is a return to the sense-impressions themselves, and a comparison of the remembrance with the object of perception. In later experiments, Finzi reported a remarkable phenomenon which has been confirmed by others, namely, that when reproduction takes place after a long interval, the subjective assurance is again increased although the objective correctness of the memory has now decreased.

We may still inquire what phase of observational noting profits most from training,—the accuracy and reliability of perception and imprinting, or the number of imprinted data? Finzi is of the opinion that reliability is increased more by training than is the amount noted. Thus the formal and functional aspect of memory derives more profit from training than does the material aspect.

A particularly important result of Finzi's investigation is

his discovery that the most diverse individual characteristics may exist in combination, in observational noting. Thus, for instance, an especially great distractibility of attention and a great capacity for training and habituation may be present in the same individual; and we may find a combination of increased compass of memory with increased fidelity and trustworthiness, etc. We have, as yet, no definite knowledge as to the interdependence of these individual characteristics. It is probable, however, that they are relatively independent of one another, because in the same individual we may find a great distractibility of attention and yet notwithstanding this a great capacity for training in its formal and material aspects.

Finzi's experiments have been extended in many directions by later investigators. Schneider, Reinhold and Kraus employed Finzi's apparatus in a study of the sensory apprehension of the insane. Kraus found that the diminished memorial capacity, in a mental disorder which is known by the name of Korsakoff's disturbance of memory, may be due chiefly to a retardation in the rate of the process of apprehension. This shows us again how important it is that the primary duration of impressions in consciousness should be sufficiently long if they are subsequently to be reproducible. Wolfskehl investigated the gradual fading of the image of groups of letters in the case of mentally abnormal patients; Kramer investigated the same phenomenon in normal adults. Wolfskehl believes that he was able to show that noting capacity decreases a short time after the presentation of the material, or more strictly speaking, that the memory-image fades at this time; on the contrary, Kramer found, as did Finzi, that irregularly periodic fluctuations in the fidelity of the memory-image appear at different intervals. A uniform initial decrease and a subsequent increase does not, however, occur; an

increase in the fidelity of the memory-image is found to be present shortly after the stimulation takes place. Kramer made a determination of the progressive course of reproduction after noting, at intervals of five seconds, for a total period of ninety-five seconds.

Kramer discovered that one's capacity for noting is improved by practice and that different types of noting may be shown to exist. The most diverse individual characteristics may be present in the noting of the same individual, as Finzi also had found. Kramer cites the following combinations: *1.* amount very great, reliability moderate; *2.* amount very slight, reliability very slight; *3.* amount moderately great, reliability moderate; *4.* amount not very great, reliability great.[1]

The determination of such combinations of individual characteristics may be of importance in teaching; they show the teacher what divergences are to be eliminated in his pupils. Ranschburg and Boldt[2] found that capacity to apprehend and to note is present in increased degree in cases of abnormally agitated emotional life.

Ranschburg has introduced important innovations in the testing of noting. His method of pairs of words is especially useful in combination with the method of correct associates (*Treffermethode*). Pairs of significantly related words are presented to the observer in auditory or visual fashion; and he is subsequently asked to respond with the second member of the appropriate pair when he hears the first member of that pair. His correct associates are recorded, together with

[1] All of these investigations were published in *Kraepelin's Psychologischen Arbeiten.*

[2] P. Ranschburg, *Das kranke Gedächtnis*, Leipzig, 1911. K. Boldt, Studien über Merkdefekte, *Monatsschr. f. Psychiat. u. Neurol.* XVII., 1905.

his association-time which may be measured by means of a stop-watch. This method is capable of a variety of uses, in that syllables may be substituted for words in order to test mechanical retention, and the test may be extended to include delayed instead of immediate reproduction. Ranschburg has devised an ingenious apparatus for the visual presentation of words and syllables;[1] he employed this apparatus in an investigation of the relative efficiency of verbal memory in normal and sub-normal pupils. He found that these two classes of pupils are sharply differentiated by the results of this method. Sub-normal pupils are characterized by a lesser number of correct associates, and by a slower reproduction; their reproductions contain many words which are not significantly related to the words which aroused the reproductions.

His investigation of abnormal memory, in paralysis, delirium, etc., shows that the process of apprehension and imprinting may be unimpaired in a patient whose other mental functions are seriously impaired; but delayed reproduction or genuine retention is always defective when apprehension and imprinting are defective. This proves again that imprinting and retention are psychically distinct processes. Since imprinting is usually measured in terms of immediate reproduction, psychopathology warrants a differentiation between temporary and permanent retention.

Investigations of the memory of mental defectives show that the pathology of memory may make important contributions to the solution of the problems in which we are interested. It enables us to compare the observational noting of normal and abnormal individuals; and such a comparison is illuminating because it shows us the factors upon which the successful accomplishment of observant noting depends. Then, too,

[1] This apparatus is described on page 108 of this volume.

the study of the abnormal mind enables us to analyze the process of noting in a much more thorough-going fashion than is possible by means of introspection alone. Since, in certain cases, the impairment is found to include only a part of the group of component processes which are concerned in the act of noting, we are furnished with a means of isolating certain of the components from the group; and we discover that processes which seem to introspection to be simple and unanalysable are really composed of more elementary components. The experiments of Finzi, Ranschburg, Goldstein and Boldt yield two chief results, in so far as the composition of the process of observational noting is concerned. *1.* The essential factors which contribute to successful noting seem to be: concentration of attention; a rigid adherence to a goal of observation; a certain rapidity of imprinting; a keen interest in the object observed; an active attention; a rich store of ideas with which the observed content may be brought into relation; an easy mobility and a ready command of these relation-ideas; and an integrity of memory itself. *2.* Noting is found to consist of a number of relatively independent component processes; and in cases of mental disease the impairment may be restricted to one or other of the components. The following components may be enumerated: capacity to concentrate the attention and to become a concentrated individuality; the whole process of apprehending and imprinting; the vivid immediate "after-effect" of stimulation; the normal development of genuine processes of reproduction in which the definite and correct verbal designation of the observed content plays a leading part; and the lasting retention, or the persistence and fidelity of the memorial dispositions which have been laid down by the process of noting.

Now the technique of noting must aim to develop all of

these component processes of noting. Since experimentation can show us which of them are ill-developed in a given individual, we possess a means of remedying defects in the individual's endowment by prescribing training of a special sort. A comparison of immediate and delayed reproduction is especially illuminating in this regard. Errors in immediate reproduction indicate that imprinting is defective; and individuals who are prone to such errors should be given a special training in observing. Errors in delayed reproduction, if they occur in combination with efficient immediate reproduction, indicate an unreliable memory; individuals in whom this defect is found should be given special exercises in memory training.

Investigations which have dealt with the retention and the revival of complex sensory material show a wholly different state of affairs. In every-day life and in the school-room this sort of observational noting is much more frequently employed than is the imprinting of simple sensory material. But still we must not lose sight of the fact that the latter sort of imprinting contains the elements of the former, and that in the noting of complex impressions we are always concerned with the noting of elements; yet in the apprehending and imprinting of complex impressions a wholly new feature is added,—the apprehending and imprinting of a total impression of a complex sort,—and the elements are in most instances imprinted only as component parts of this total impression. Experiments dealing with complex stimuli have shown us the significance of another group of subjective conditions of observational noting, particularly that of the view-points of observation, of the direction of the observer's interest, and of other individual characteristics of the observer.

c. *The Investigation of Testimony and Noting*

Only within recent years has our experimental technique been extended to include the noting of this sort of material, the investigation of testimony, among other causes, furnishing the impetus. The investigation of testimony consists in presenting to the observer a picture, a concrete object, a process or an event, and in having him describe his experience after the objective stimulus has been removed. The observer is given a definite time during which the picture or object may be examined; and the period of exposure is short, usually less than one minute, in order that attention may be keenly concentrated throughout. During the presentation the observer must, in accordance with instructions given him in advance, imprint the object upon his consciousness as accurately as possible. Then it is withdrawn, and immediately afterwards a complete description of the object is recorded in writing. Here, in conformity with a suggestion by Stern, we must distinguish between a spontaneous and independent description or report, and an interrogation or cross-examination. The report comprises the testimony offered by the observer in a voluntary and spontaneous manner, without aid of any sort. As a rule the interrogation follows the report, taking the form of a systematic questioning addressed by the experimenter to the observer. The aid received from the experimenter's questioning may be combined with an attempt to determine whether the observer is susceptible to suggested impressions which were not received during the presentation; in other words, the observer's suggestibility may be investigated. Both the report and the interrogation may come at different intervals after the material has been presented. If they come immediately after the presentation, we make a test of observation and its effect as manifested in the imme-

diate retention of complex impressions. If they do not come until after a considerable time has elapsed, we deal with true memory; and from a comparison of the results obtained after the lapse of different intervals we may determine the progress of the forgetting of complex material.

These investigations of testimony are also investigations of observational noting, for the observer has explicit instructions so to imprint the material that he may give the fullest possible testimony concerning it. For instance, in Stern's experiments the following instructions were given to the children who served as observers: "I should like to find out if you have a good memory. I am going to show you a picture; and you are to look at it carefully. I shall give you ample time to note everything which it contains. Afterwards you will describe all that you saw." If in the description which followed, the child came to a point where he hesitated he was told to "Think again; perhaps you will remember something else." When he could find no more to report he was asked, "Does nothing else occur to you?" When finally he replied in the negative, his report was taken to be finished and the interrogation began.

The picture which Stern employed was a colored print of a peasant's room, from a portfolio of pictures published by Schreiber in Esslingen. Other investigators have employed somewhat different pictures, in some cases more complex. Lobsien's picture represented a boy engaged in fishing. Oppenheim used two pictures from Schreiber's collection; one of them symbolized water, and the other showed peasants at work in a field. Experiments of this sort have been made by Stern, Wreschner, Lobsien, Marie Dürr-Borst, Rodenwaldt and others.[1]

So far as our purposes are concerned, these investigations

[1] See Bibliography at the end of this volume.

of testimony have the disadvantage that the effect of observation upon testimony itself has not been submitted to an adequate investigation. These experiments therefore yield little more than a statistics of testimony from which, of course, certain important conclusions bearing upon observing and noting may be drawn; but they do not contribute directly to a solution of our problem.

From the investigation of testimony there has developed a group of experiments which deal directly with the noting capacity of adults, normal and abnormal, and of school-children. Experiments of this latter sort were conducted by Bogdanoff, and by Bernstein and Bogdanoff;[1] others were undertaken by Boldt, Netschajeff, Brodmann, Ranschburg, Goldstein, Lobsien, and by Schroebler and the author. Among these we must mention, first of all, the pioneer experiments of Ranschburg and Goldstein because these writers call attention to a number of extremely important objective conditions of observing and of noting, and contribute to an accurate analysis of the processes employed in these two functions. Ranschburg improved the technique of experimentation in this field by introducing a very useful apparatus which he calls the mnemometer. This is a small box with an aperture in the lid, under which rotates a disc driven by a spring. Numbers, words, pictures, etc., pasted upon the disc can be made to appear and to disappear, in successive order behind the aperture, at any desired rate of speed. Ranschburg's results show, first of all, that the ease and accuracy of observational noting depends in great measure upon the character of the objective stimuli, particularly upon whether the stimuli differ from one another or contain similar or identical elements. His experiments led to the formulation of the important law that impressions are apprehended more rapidly and more

[1] See Bibliography at the end of this volume.

correctly in proportion as their stimuli are diverse; and they are apprehended less readily and less correctly in proportion as their stimuli are similar or identical.[1] This law may be demonstrated from the apprehension of series of numbers. Several groups containing from two-place to six-place numbers were exposed for periods of one-third of a second in the mnemometer, some of the groups containing wholly different digits (210 864), and some containing similar or identical digits (471 038) (929 968). It was found that groups containing similar or identical digits were erroneously perceived much more frequently than those containing wholly different digits. There were also certain remarkable subsidiary results. For example, errors seldom occurred at the left side of the column; approximately ninety per cent. of the false readings occurred in the right half of the group of digits.[2] The final digits of the numbers, however, were perceived correctly in almost every instance.

In these erroneous perceptions certain fundamental types of error recur with great frequency. Similar digits tend to fuse with one another in reproduction; for instance, 3 is often confused with 8, 9 with 6, 2 and 0 with 9. "The dimly perceived digits either lose certain of their finer details or they appropriate other details." For example, 194 607 was read instead of 194 907; 491 238 instead of 491 938, etc. When two similar digits stood side-by-side and one of them was imperfectly perceived, the latter was transformed into the former,—a very frequent type of error. One digit was substituted for another which bore no resemblance to it, as 4 for 9, 7 for 8, etc. Again when a digit was imperfectly per-

[1] P. Ranschburg, Ueber Hemmung gleichzeitiger Reizwirkungen, *Zeitschr. f. Psychol.*, XXX., 1902, 39–86.

[2] This may possibly be due to the influence of our having learned to read from left to right.

ceived, a digit which was similar to one of its neighbors was substituted for it, thus 811 824 was read 811 224; or the digit next in numerical sequence was substituted for the imperfectly perceived digit. Ranschburg refers to these as simple errors, employing the term complex error to indicate transpositions and the like. It was found that certain series were read on the whole correctly and others incorrectly; and in particular, it was found that when digits containing straight lines,—1, 4, 7,—stood in the third, fourth or fifth places, the reading was especially accurate. This also shows to what an extent ready and correct apprehension depends upon the objective character and the external arrangement of the stimuli. The almost invariable absence of error at the left of the column of digits is referred by Ranschburg to the habitual direction of the progress of attention, as in our reading from left to right.

The results may then be summarized in this statement: "Illusions in the apprehension of complex stimuli are due to two causes: *a.* the composition of the series,—homogeneous elements increasing the illusion; and *b.* the behavior of attention, which seems to turn first to the beginning or left-hand side of a series of graphic signs. This behavior in turn is a product of habit and training, and seems to follow a regular law. "In a minimal period of time, the attention is able to grasp a greater number of sensations or ideas when they are aroused by heterogeneous stimuli than when they owe their origin to homogeneous stimuli," or "The threshold for the apprehension of simultaneous or immediately successive heterogeneous stimuli is lower than for homogeneous stimuli presented under identical conditions." Ranschburg refers to this as the law "in accordance with which apprehension is rendered more difficult by the presence of identical elements." Many other investigations justify the conclusion

that this law holds for simultaneously perceived as well as for successively perceived stimuli. Ranschburg seeks the cause of this phenomenon in the circumstance that similar or like elements inhibit one another in the process of apprehension. They are unable to hold their own in the struggle with their heterogeneous rivals for possession of the narrow field of consciousness. This is expressed by Ranschburg in the significant statement that "intensity and affective tone being equal, the dissimilar members of a group of stimuli which act upon consciousness at exactly or approximately the same time are given the preference; while those which are similar or identical inhibit one another." This formulation is employed by Ranschburg to give special emphasis to the fact that the inhibition of homogeneous stimuli operates in utter independence of all the conditions of noting which owe their origin to the intensity and the emotional tone of stimuli.

All of this has a distinct pedagogical significance. It shows us that material which is to be presented concretely must be selected carefully in so far as its objective difficulty is concerned; and that concrete material is perceived more readily and more significantly in proportion as it is composed of simple elements,—digits containing straight lines,—and of dissimilar elements. It is also of importance to pedagogy that the observer finds greater difficulty and requires more concentration in apprehending groups which are "encumbered" with similar elements than in apprehending groups which are made up exclusively of heterogeneous elements.

A number of important experiments by Goldstein[1] dealing with observational noting in the insane, are, in a sense, a supplement to those of Ranschburg. They are a continuation of previous investigations by Diehl and Bernstein, Ransch-

[1] K. Goldstein, Merkfähigkeit, Gedächtnis und Assoziation, *Zeitschr. f. Psychol.*, XLI., 1906, 38–47; 117–144.

burg and Boldt, but they go much farther in the analysis of the processes employed in noting. In a first series of experiments, Goldstein presented to his (abnormal) subjects twenty-three stimuli or objects to be noted, in successive order,—three significant words, three familiar objects, three uncolored pictures, three colored pictures, three two-place numbers, two street addresses, three colors (skeins of yarn), and three coins. The observers were allowed to regard these objects until they felt that they had imprinted every detail clearly upon memory; then after intervals of one minute, five minutes and twenty-four hours, Goldstein determined how much was remembered. In a second series of experiments, single objects were presented; and these were described after very brief intervals,—five, ten, twenty, forty, and sixty seconds. Here again two different sorts of stimuli were employed,— in one case, stimuli which gave least opportunity for associative connections; and in the other case, stimuli which were rich in associations. The former objects included two-place, odd numbers; and the latter, a colored picture whose content was familiar to the observer. In the case of the picture, retention was tested by the method of recognition; in the case of the numbers, a reproduction of the digits themselves was demanded. In a third series of experiments, the time which intervened between observation and reproduction was filled with distracting stimuli: similar stimuli being employed in half the experiments, and dissimilar stimuli in the other half. The distraction took the form either of a naming of pictures (after numbers or pictures had been perceived), or of simple arithmetical calculations.

These experiments aimed to make a test, in certain cases, chiefly of immediate retention and imprinting itself, and in other cases, chiefly of the true retention which had been accomplished by means of associative aids. The investiga-

tion yielded the important result that the same observer may show a creditable capacity in "noting for only a short time," that is, in immediate retention, but a poor capacity in noting for a longer time; and that noting by means of simple imprinting (when numbers are presented and associative ideas are lacking) may be poor in an observer whose noting by means of associative aids (pictures) is highly developed. It was found, further, that even when an individual possesses a good capacity for imprinting and associating, his acquisition of concrete material may still be very imperfectly developed; this is the case when he proves to be an individual who lacks interest in the experiment and does not will to acquire information.

These results give us a clearer insight into the nature and the component processes of the act of noting. They show us *1.* that in the act of noting, the process of imprinting (called "simple imprinting" by Goldstein) possesses, to a certain extent, a significance which is independent of the formation of associations. We must, therefore, distinguish between the simple or direct imprinting of stimuli which is relatively independent of the formation of associations, and noting which is accomplished by means of the formation of associations. The former process gives rise to a direct reception of impressions; the latter to a reception through the medium of familiar ideas. The two activities coöperate in every act of sense-perception; but now the one, now the other may predominate. Pure direct imprinting comes into operation especially when we are dealing with impressions which are relatively lacking in associations, and when the time for perceiving is very short. In cases of the opposite sort, associative noting predominates.

These experimental findings furnish another confirmation for my distinction between immediate and lasting retention.

Immediate retention depends much more upon the process of imprinting than upon the formation of associations, because the latter is precluded by lack of time under the conditions of the experiment. Immediate retention may be strong in an individual whose lasting retention is weak, and *vice versa;* and this non-correlated distribution of the two functions of memory is to be referred to the effect of imprinting and of associating. Immediate retention appears to be the special effect of imprinting, while lasting retention is the special effect of association. Immediate retention and the effect of imprinting are correlates. Indeed, the associative function may be seriously impaired in the insane without immediate retention being sympathetically affected. And it is for this reason that capacity for imprinting and capacity for associative noting may show different degrees of training and development in the same individual.

As regards the effect of distraction during the period which intervenes between presentation and reproduction, Goldstein found that in all of his observers distraction gave rise to a more serious impairment in the retention of numbers than in the retention of pictures; and that distraction by means of a homogeneous stimulus,—*i.e.*, when pictures were introduced after pictures had been observed,—is more effective than distraction by means of a heterogeneous stimulus. He recognizes that this phenomenon is analogous with Ranschburg's finding that homogeneous impressions and ideas inhibit one another more than heterogeneous. But at the same time, it shows that distraction has a more disturbing effect in immediate retention; and this accords with Goldstein's further observation that the "formation of associations actually has a disturbing effect upon noting capacity for shorter intervals." This shows the pure imprinting of impressions to be a special process which has its own peculiar conditions and results.

Goldstein's observations give us still more information concerning the component processes which constitute observational noting. We see, namely, that this act consists in a coöperation of *1.* the concentration of attention; this probably is of the nature of a general condition upon which depend not only the result of the imprinting and the formation of associations, but also and chiefly the imprinting itself; *2.* the process of imprinting; *3.* the formation of supporting associations, which constitutes, for the most part, the incorporation of the content of perception into our body of former ideas, and renders possible the establishment of associative connections; *4.* the will to observe and to note. The will to observe is to be regarded as a different direction of the will from that which is present in noting. Its presence is seen in the individual's interest in the acquisition of the concrete material; and its absence manifests itself in an indifference on the part of the learner. To these must be added as additional conditions of observational noting the objective relations, homogeneous or heterogeneous, of the stimuli, which Ranschburg specified, and the significance of the intensity and emotional tone of stimuli, which have long been known to psychology. Hence we find a multitude of coöperative processes and conditions in noting.

It is a matter of prime importance that each of these factors appears to have its special influence upon the results of the whole process of noting. There are only two of the factors, however, which are to be regarded as genuine functions of memory, namely, imprinting, and the forming of associations. Imprinting clearly has the chief significance in the immediate reproduction of impressions; while the formation of associations is chiefly significant for permanent retention, (after the impressions have wholly disappeared from consciousness) or for the genuine function of memory. Yet

investigations of the insane show that associative noting is, in its very nature, dependent upon the excellence of the association mechanism, or upon the quality of the individual's function of association and reproduction. Imprinting and immediate retention, on the other hand, are independent of this; that is, they may function normally even when the associative mechanism is pathologically impaired.

Just as these experiments give us an insight into the process of noting, others, such as those of Bernstein and Bogdanoff, are especially illuminating regarding the effect of noting and, in particular, of the retention of complex impressions as a result of observational noting. They have an especial value in that the material which they employed is closely related to that with which children are concerned in the school-room. Bernstein did not employ ordinary pictures, but simple geometrical figures which had been drawn upon a screen. The screen was marked off into nine squares, arranged in three rows; and each square contained a figure. The figures were simple forms, as a square with one diagonal, a two-armed cross, two triangles with their apexes joined, etc. For ease of observation the screen was framed, and placed in the hands of the observer. The children who served as observers were allowed to examine the group of figures for a period of thirty seconds; the observational noting or the retention of the material was then tested by a method of recognition. There was now laid before the observer a sheet containing twenty-five simple geometric figures, among which appeared the nine original figures distributed in irregular order, together with nine others which resembled them somewhat, and seven wholly new figures. The procedure consisted in having the observer identify the figures which he had seen in the original series upon the screen. The method assumes "that those figures which were imprinted accurately upon memory will

now be identified without error, and that therefore the number of figures identified upon the second sheet will correspond with the number retained in memory." If this number is brought into relation with the total number of figures observed upon the original screen, then we shall have the ratio $\frac{n}{9}$ as a measure of the observer's noting capacity. "If the observer selects from the second group any figures which were not present in the original series, the number of false identifications must be brought into relation with the proportion of correct identifications, $\frac{n}{9}-f$, that is, the relative number of correct and of false statements constitutes what we may call the co-efficient of noting." (Bernstein.) Similar experiments had previously been made with abnormal subjects by Bogdanoff; he and Bernstein together continued the investigation with children,—twenty-eight observers between the ages of seven and fifteen years,—in one of the high schools of Moscow.

Their results give us much valuable information relating to the psychology of observational noting, although being influenced by current investigations of testimony, the experimenters were unfortunately content to give an inadequate numerical statement of their data, and did not make a sufficiently thorough investigation of the process of observing itself.

From all of these experiments we see that, in general, the number of correct statements increases fairly regularly with increase in the age of the child. Bernstein extended his investigation to include a test of "passive attention"; that is, after each experiment he asked his observers whether they could state how many figures appeared upon the second sheet. Since the children had had no reason to expect that this question would be asked them, it may be assumed, in the majority of cases at least, that they did note this feature deliberately or intentionally. In any case, such a question

must yield very uncertain results because, of course, the deliberate and intentional imprinting of the number of figures upon the second sheet might have taken place, and because it was not difficult for the children to calculate the number of figures from the general appearance of the sheet since it contained five rows and each row contained five figures. For these reasons the numerical data obtained from the answers to this question show that "passive attention" is very irregular in its development.

One is surprised to find that some of the observers made a great many erroneous identifications; indeed, certain of the eighteen-year-old observers marked upon the second sheet as many as six figures which bore no resemblance to the original figures. And even when the number of errors was not so great, it is surprising that certain figures which had not been seen in the original series were sometimes "identified." In general, however, it turns out that noting capacity improves with increase of age; it reaches its maximum in the fifteenth year, and subsequently declines. Additional experiments with thirty-five adults showed that, on the average, adults are more efficient,—their averages being 7.6 correct and .8 erroneous identifications. But at the age of fifteen the average number of correct statements is 8.2. The results are shown in the following table:

Age	*Total Number of Identifications*	*Number of Correct Identifications*	*Number of Erroneous Identifications*	*Age*	*Total Number of Identifications*	*Number of Correct Identifications*	*Number of Erroneous Identifications*
8	8	6	2	13	8.5	7.5	1.0
9	8	6.4	1.6	14	8.4	8	.4
10	8	6.6	1.4	15	8.8	8.2	.6
11	7.8	6.9	.9	Adults	8.4	7.6	.8
12	8.3	7.1	1.2				

The important feature consists in the fact that the correct identifications increase in proportion as the erroneous identifications decrease. This relation gives one the impression that correct and erroneous ideas suppress one another. It is remarkable, too, that younger children make relatively few correct statements and a very large number of false, a feature which is especially noteworthy since the number of impressions to be noted was only nine. This indicates that capacity to observe and to note is but slightly developed in the earlier years.

Boldt's[1] investigation is not so important, because only six objects were presented. This number is decidedly too small. Netschajeff's method[2] consisted in displaying twelve colored pictures of large size, and as nearly as possible of similar coloring. Each picture was shown for five seconds; then the child was asked to pick it out from among a group of thirty-six pictures. Here, too, the accuracy of recognition was found to increase with age.

The actual investigations of testimony are in some respects more instructive than the investigations of noting capacity which we have mentioned, because they have endeavored to make a more accurate evaluation of the psychological statistics of testimony. There are three groups of these experiments which must especially be mentioned here: *1.* The pioneer investigations of Stern and Wreschner, the former dealing with children and youths, the latter with adults. *2.* Rodenwaldt's experiments with soldiers must be brought into comparison with this first group. Rodenwaldt investigated the testimony of adults of about the same age as Wreschner's, but of a lesser degree of intelligence. *3.* The

[1] K. Boldt, Studien über Merkdefekte, *Monatschr. f. Psychiat. u. Neurol.*, XVII., 1905, 97–114.

[2] A. Netschajeff, *Ueber Auffassung*, Berlin, 1904.

third group of experiments concerns the important question as to whether testimony and capacity to observe and to note can be trained and improved by practice. This question was investigated by Oppenheim, Borst, Baade, Lipmann, Ranschburg, Schröbler, Meumann, and others.[1]

We have already described the method employed in Stern's experiments. His material consists exclusively of the colored picture of the peasant's room. This picture represents a simple peasant's hut, in which a man in shirt-sleeves and colored vest is sitting at a table. The family is beginning their meal. The husband has a plate before him, and in his right hand a spoon. He is looking toward his wife, who stands at his right and is in the act of setting a pitcher on the table. Opposite the wife and to the left of the husband, a small child is sitting upon a bench, with a plate before him; he is in the act of bringing a spoon to his mouth. Beside him and at his left is a dog. At the side of the table, which is turned toward the spectator, is the wife's chair, and upon the table, her plate and spoon. The supper-dishes are upon the central part of the table. To the left is a blue cradle containing a baby. A large bed stands in the background; and upon the wall are three pictures and a crucifix. The window has a partially lowered shade and a pair of rose-colored curtains; plants can be seen through the window. Upon the wall, to the right, is a Black Forest clock; the room has a timbered ceiling.

Rodenwaldt has justly remarked that this picture is not altogether appropriate for experiments in testimony. The clothing of the family, the beard of the peasant, and particularly the woman's dress are most unusual. Then, too, the perspective of the picture is exaggerated to such an extent that the floor must seem to children to be non-horizontal.

[1] See Bibliography at the end of this volume.

It was Stern who furnished the chief points of view for the evaluation of experimental data, in which, for the most part, he has been followed by other investigators, although there have been certain essential variations in the computation of results. Distinctions have been made between the amount and the accuracy of testimony, and between free or spontaneous testimony and that which is obtained when spontaneous memory is aided by interrogation or cross-examination. It is important to note that spontaneous testimony is always much more limited in scope and content than total testimony, the latter term referring to the combined spontaneous and interrogatory product, or to the total amount reproduced. Thus, when an observer reports his experience spontaneously, his report by no means represents the complete content which was left in his memory by the original sensory impressions. There is, as Stern points out, a mass of mental content in addition to this spontaneous product which can be reproduced only at the instigation of an external impulse. Indeed, in many instances, the spontaneous portion amounts to only one-half of the total remembrance. Spontaneity is measured by a fraction which expresses the ratio between the amount of spontaneous content and of total content: $\frac{cs}{ct}$, where *cs* indicates the number of correct spontaneous statements, and *ct* the total number of correct statements.

For the purpose of the present discussion, we shall utilize only those results of the investigation of testimony which afford us an insight into the conditions of observational noting. These may be summarized as follows: In the first place, Stern's experiments show that a determining factor in the result of observation and of the report of what has been observed consists in the point of view from which the observation was made; that is, it is important that the observer should possess and should properly utilize all of the points of

view which contribute to a complete analysis of the observed object. This comes to light more clearly in Stern's experiments where he employed children of different ages. His results enable us to correlate the different points of view or categories of observation with the age of the observer, because certain categories of retention have not yet been acquired and mastered by the young child. Hence it is possible to differentiate various stages of development in observational noting according to the dominance or absence of particular points of view of observation.

Accordingly Stern distinguishes several levels or stages in the development of observation. The first stage, which prevails at about the age of seven years, Stern designates as the *substance* stage; here the child enumerates persons and things without coherent connection. Next in order comes the *action* stage, which extends to about the tenth year; here the chief objects of attention are the activities of people. The third is the *relation* stage, where chiefly the relations of things, and particularly their spatial relations, attract attention; this stage makes its appearance at about the twelfth to the fourteenth year. Finally, from about the fourteenth year onward comes the *quality* stage, where the properties of things are observed and analyzed. The following description of the peasant's room by a seven-year-old girl illustrates the *substance* stage: "A man, a woman, a cradle, a bed, a boy, a chair, a bench, a doll, three pictures, a cross, a window, a boot-jack, a table, a plate, a dish." The following report by a nineteen-year-old student illustrates the *quality* stage: "A room with ceiling of wood, probably oak; upon one of the walls there hangs a picture, with gilded frame, of a small house and a tree. A window with a shade partly rolled up, and a picture upon it. In the foreground, a table with brown, turned legs, etc." The results of these investigations of testimony and

numerous experiences from every-day life show that what we perceive in an object is determined chiefly by the points of view or categories or directing ideas from which we observe it. This is illustrated in the familiar experience that when a layman and a person who is trained in some particular art or trade or profession observe the same phenomena the professional man always sees much more than the layman. The former has a great many special points of view from which he observes things; and these are relatively lacking in the case of the layman. We shall see, however, that the mere presence of points of view is relatively unimportant; much more depends upon their proper utilization, and upon the observer's efficiency and perseverence in the act of observing. For, by intensity, persistence and thoroughness of observation the observer may acquire view-points from the objective material itself.

An important question arises here: What proportion of the observer's testimony belongs to each of the different categories? An answer to this question would enable us to determine what items are selected by observers of different ages, of different levels of mental development, of different degrees of education; and what items each observer would therefore imprint especially upon memory, for testimony is a product of observation and noting. In this respect, Rodenwaldt's experiments constitute an exceedingly important supplement to those of Stern. Let us, however, first consider Stern's results. This investigator's answer to our question is contained in his discussion of "spontaneity values," by which he means the ratio of the number of items included in the spontaneous description to the total number of items contained in the original picture. This conception is not wholly free from objection, however, because one can never be sure of just what is to be regarded as the actual content of the presented object.

According to Stern the "spontaneity value" is "a measure of the selection made by the observer, and therefore an index of the independent and spontaneous interest which a given category of items is able to arouse in him." This may be expressed otherwise as follows: Whenever anything is observed spontaneously, a selection is made among the observed data; and this selection may be taken as a measure of the dominant interests of the observer. Stern found three chief categories of items which are preferred above all others: *1*. Persons are much more spontaneously observed and noted than things. *2*. Things are much more spontaneously observed than the properties and relations of things, that is, substance is much more interesting than accident. *3*. Spatial arrangement is much more readily observed than color. Indeed, the latter is ignored to an extraordinary degree; children and young people generally agree in paying little heed to colors.

Wreschner obtained similar results. He, too, found that the compass of memory is less for data of an objective than of a personal sort, and that colors are but slightly noticed. It is significant in this connection that many features in the picture of the peasant's room which made a striking appeal to the senses, for instance, vividly colored objects, did not attract attention. As Stern points out, it is not by any means the intrusiveness of the stimulus itself which attracts the attention. When left entirely to itself, observation directs the attention not to the intensity or the quality of the stimulus but primarily to those features which are of practical significance, that is, which have greatest interest as practical concerns of life. Stern adds that among our practical interests the personal are paramount; hence he asserts that the selection of that which we observe voluntarily and spontaneously is made in accordance with a principle which may be designated a "practico-anthropocentric evaluation."

This conception is essentially narrowed by Rodenwaldt's findings. It is to be noted, however, that Rodenwaldt experimented exclusively with adults (soldiers). He, too, found that the practical point of view is dominant in observation; the features preferred are, however, not personal relations, but things throughout. One even finds that his observers begin their description of the picture with a detailed enumeration of objects and their properties,—table, bed, ceiling, floor, etc.; and that not until later and quite incidentally do they speak of persons and their actions. This phenomenon is doubtless due to a difference in the age and in the mental development of the observers in the two cases. With increasing age one's interest in personal matters declines, and one's interest in things begins to preponderate. Nevertheless, Rodenwaldt found that things are more accurately and more fully observed than are the qualities and relations of things; and among things and qualities the practically significant preponderates,—for example, spatial relations predominate over colors.

In general, then, it must be said that in cases where attention has not been specifically trained, it is not genuinely attracted by sensations and their attributes as such, but by objects of practical interest or of practical significance (Stern, Rodenwaldt).

We are to bear in mind, however, that this statement is true only of individuals who have not received systematic training in observation. The experiments of Stern and Rodenwaldt deal only with the spontaneous or free and unconstrained type of observation. If we examine the observation of the scientist or the artist, we invariably find evidence of the influence of training in that more heed is given to that which conforms to their scientific or artistic interests.

These earlier investigations of testimony laid the founda-

tion for an illuminating group of experiments which have since been undertaken. The later investigations aimed to deal chiefly with the following problems: *a*. Can the testimony of the child be so modified by training that he will begin at an early age to employ those points of view which Stern found to be present only at a later age? *b*. Experiments in testimony must be checked and controlled by experiments in observation. The child should be required to observe objects from particular categories or points of view while still in the presence of the objects. And these experiments should be of two sorts. In the first group the child must be left wholly to his own guidance; in the second group the points of view are to be indicated to him. Not until we are able to compare and to contrast free and directed observation, together with the subsequent remembrance of the observed data in the two cases, shall we be able to determine whether and to what degree the child is capable, at a particular stage of his development, of employing a particular category or point of view of observation. This problem of observation was investigated by Meumann and Schröbler, and the investigation was continued by Schröbler alone in an extensive series of experiments. The observers were boys and girls from six to fourteen years of age; and the materials consisted of pictures, stuffed animals and sculptured figures. It turned out that two forms of free observation must be employed. In one case, only the most general questions are to be asked; for instance: "Can you tell me what you saw?" In the other case, the experimenter is to resort to artifices in order to encourage the child to talk about the object,—for instance: "How would you describe to your mother what we have shown you today?" It is necessary to have recourse to such artifices because the descriptions furnished by many children in free observation are exceedingly meagre; older children

describe even more briefly than younger children, the latter feeling less restraint in this experiment. Well-marked individual variations were present both in free and in directed observation. In free observation the children reported but little, and after looking about in a groping fashion for some time they finally announced that they had finished; but so soon as we passed over to directed observation they seemed to feel pleased and relieved, and their reports became much more detailed and extensive. One can plainly see that these children can observe, but notwithstanding all of their object-teaching, they have acquired so little method of observation that they are helpless. They have no means of finding their way about amid the wealth of detail, nor of assuming any definite points of view. And even in directed observation it is evident that although points of view are furnished to them they simply fail to see certain things which never escape the notice of adults.

This shows that pupils are in need of systematic guidance in observation; they must learn to observe methodically. Our present system of object-teaching emphasizes material content in a one-sided fashion; it furnishes the pupil with facts but with no training in observing. And not until he possesses the latter can he succeed in observing in an independent manner. Experiments which have dealt with the educability of perception give us an insight into our present problem. These experiments have been arranged in two different ways: *1*. Children are actually guided in the proper and systematic use of particular points of view of observation, and they are encouraged to work carefully, conscientiously and with good will. *2*. Experiments of similar character follow one another, errors being pointed out and corrected after each experiment. Obviously, the former method alone is educative in any genuine sense; the object

which the latter method seeks to attain is self-help, and for that reason this method is more appropriate for adults than for children. Experiments of the former sort have been undertaken by Oppenheim and Borst, of the latter sort by Breukink, Baade, Lipmann, and others. Within a period of three months Oppenheim made three tests of a group of thirty girls from ten to twelve years of age, employing the picture method devised by Stern. After each test free reports and interrogatory reports were recorded; then the picture was again shown to the observer who was now asked to discover her own errors. Finally, the experimenter pointed out any errors that she had herself not been able to discover. The observer was then admonished to observe accurately in future and to make her report as complete and as correct as possible. This process of education resulted in an essential improvement in subsequent reports. The errors decreased from twenty-six per cent. in the first experiment to seventeen and one-half per cent. in the third experiment. But the improvement in quality was much less marked in the spontaneous descriptions than in the interrogatory reports. While the former increased progressively in amount but not in accuracy, the latter became errorless; and the observer's capacity to resist suggestion steadily increased.

Oppenheim's method did not provide for any real education of observation and description, because mere indication of errors and admonition to improve do not constitute education; guidance as to mode of procedure in accurate observation was wholly lacking. Education is possible only when observers are systematically instructed in the use of particular points of view in observation.

Borst made the pioneer attempt to educate individuals in the acts of observing and describing. Her experiments were conducted in the public schools of Zurich; her observers were

sixteen pupils, six and seven years of age. The pupils were instructed to employ definite categories in observing. These categories were first explained clearly to the children who were then given practice in using them. The describing capacity of the unpracticed child was determined at the outset; this preliminary test was followed by practice experiments with pictures, all as nearly equally difficult as possible. Then the effect of practice was tested by showing new pictures and noting the differences in these later descriptions by the pupil. Three methods of education were employed: *1. Method of general guidance.* This consisted in teaching the children to employ particular points of view of observation and to make a systematic observation, from one point in the picture, of all the details from the different points of view which came into consideration. *2. Method of raising the apperceptive masses.* Here the children were made familiar, after the first experiment, with the sensory material to be observed; they were given formal instruction concerning colors, forms, relations of magnitude, etc., and concerning the naming of these impressions. *3. Method of influencing the will.* Here an appeal was made to the feelings and the will of the observers; their interest was aroused, a desire to improve was inculcated, and especially was the feeling of responsibility intensified.

A very definite improvement in description resulted from the third method. The first method actually impaired the reports,—a negative result which is to be explained from the fact that mere admonition to observe systematically from different points of view makes a severe demand upon children of this age, and from the fact that the experiments were not sufficiently long-continued.

Experiments of the second sort were made in great numbers by Breukink. His method consisted in a frequent repetition

of tests in testimony with a great number and variety of educated and uneducated individuals, — nurses, students, teachers and instructors of school and university rank, together with their wives; and his material consisted of pictures which were projected upon a screen by means of a lantern. The object was to determine whether the later descriptions showed an improvement. The reliability of testimony became greater and greater with the progress of the experiments; and Breukink assumes that this finding establishes the educability of testimony. As a matter of fact, the factor at work was not education but practice in observing and describing; yet it is interesting to discover that practice improves these two functions. His experiments do not show us, however, what would be accomplished by children under similar conditions. Borst had already performed almost identical experiments with adults, and had concluded that a certain improvement in testimony can be attained in adults.

Baade and Lipmann have since undertaken an investigation of educability. Their method consisted in presenting a class demonstration of physical phenomena, and their observers were children; their results proved to be essentially different from those of their predecessors. A simple physical phenomenon was demonstrated twice; after the first demonstration the errors in the pupils' descriptions were pointed out, and the demonstration was then repeated. This feature of their method is open to objection because a stimulus lacks novelty when repeated; and this factor has a great influence upon the process of apperception in children, for which reason the second observation must of necessity be less accurate. Nor did it turn out that the testimony of the observers was improved by this second demonstration. This shows that improvement due to practice does not depend merely upon

repetition, but may confidently be expected to occur only when the will to make a systematic improvement is aroused, and when a certain guidance as to how to improve by practice has been furnished, or when the (adult) observer can himself furnish that guidance.

The child's capacity to observe has recently been investigated by Netschajeff and van der Torren. But their experiments, although of interest for the theory of observation, make no contribution to the technique of learning.

Investigations of the descriptive powers of normal as compared with abnormal children have been undertaken by Ranschburg, Romer, Dósai-Révész and Moravcsik. Here again it was found that immediate retention may be "surprisingly good" in mental defectives where permanent retention is seriously impaired; and that improvement in noting with increase of age reaches its limit at fourteen years in mental defectives, often reverting soon after the age of fifteen to the level of the child of eleven or twelve years.

It would be a matter of prime importance if these investigations of testimony could show us which factors in the act of observation are especially significant for retention. The more important results of these investigations have been included in the foregoing summary; but certain inferences which follow from these and other experiments may now be mentioned.

1. Investigations by means of the tachistoscope have given us a certain insight into the significance of the temporal factor, especially the significance of rapidity and brevity of perception, as well as the importance of repeated observation. In these experiments, letters, syllables, numbers, simple geometrical figures, combinations of colors, or even complex pictures are observed under conditions of exceedingly brief presentation. The application of this experimental procedure

to the analysis of the act of reading is especially important; here the method usually consists in having the reader make repeated observations of a word or nonsense syllable which is presented for only an instant (about four or five one-thousandths of a second). The results of these experiments show that an exact visual fixation and a subjective preparation of attention are of paramount significance for accuracy of observation; and that the observer must guard against too definite anticipation-ideas and against an assimilation of anticipation-ideas with incoming sense-impressions. The more the observer is inclined to expect a particular group of sense-impressions,—that is, the more definite the points of view from which he enters upon the observation, and the less capable he is of critically testing and inhibiting the assimilation of view-point and sensation,—the more inaccurate and treacherous will be his observation. *a.* All of these experiments show that we tend to incorporate our expectation-ideas into our perception of objects, and that these two sorts of mental content are more readily fused into a unitary whole when our anticipation-ideas are definite, when our perceptions are fleeting and indefinite, and when we fail to assume a critical attitude and to differentiate beweeen the subjective and the objective components of perception. Or in other words, the attainment of an accurate and objectively valid perception depends rather upon the proper utilization than upon the mere presence of view-points of observation. We even find that those observers who rid themselves completely of all ideas of expectation observe more during an instantaneous exposure than those who have definite view-points. *b.* This is also borne out by the fact that we find two types of observer, —a subjective and an objective. The former type is inclined to blend expectation-ideas with sense-impressions, and in the subsequent elaboration of the impression, to interpret it by

a process of guessing and conjecture. Then the product of his interpretation completely supplants what was actually seen; and he finds it difficult or even impossible to distinguish his (objective) perception from his (subjective) interpretation. The objective type of observer, on the contrary, makes a sharp distinction between what he has objectively perceived and what he has subjectively added to this datum. He is able to give an account of each of these components independently, and is, therefore, more cautious and conservative in the blending and interpreting of his sense-impressions.

When the brief exposure of a visual object is repeated several times, we find that the single perceptions supplement and reinforce one another in part, but only in part. Supplementation and reinforcement seem to occur more readily in proportion as the single perceptions were accurate, and in proportion as the observer is convinced of their accuracy. The single perceptions reinforce one another less, the more fleeting and inaccurate and difficult they were, and the less subjective assurance attaches to them. Very fleeting perceptions of the same object, for instance, of a word read by instantaneous exposure, often appear in successive observations to be wholly discrete individual data, each coming to the observer as a new and original perception.

2. Stern believes that accuracy in observation and description depends chiefly upon the objective-point toward which the observer's interest is directed. Interest attaches, in the main, to persons; and in consequence, the reliability of spontaneous testimony concerning persons is especially great. It is also true that in testimony obtained by cross-examination the reliability is especially high when persons are concerned. And not only are things attended to more spontaneously than properties and relations of things, but the former are retained better than the latter. Spatial relations are attended

to more spontaneously than colors; statements regarding colors are much less reliable than statements concerning spatial relations. Numerical relations are but little heeded, and testimony regarding them is correspondingly unreliable.

If this result were confirmed it would show that *a.* the selection of that which is to be observed and remembered is determined by the interest and by the dominant direction of will; and that this is just what is best imprinted upon memory and best retained. Interest then seems to be a fundamental condition not only of attention but of memory as well. *b.* It appears that every observer adopts a procedure of critical selection among the observed data during the act of observation itself; this selection is not by any means determined exclusively by the view-point of observation, but chiefly by the unconscious participation of his evaluation of these view-points. Even the individual whose point of view consists in a desire to observe colors pays more attention to spatial relations, notwithstanding his point of view, because he regards spatial relations as being more important; and they therefore imprint themselves indelibly upon him. In numerous experiments I have found that observers continually assume and employ such view-points of value; especially do they fail to observe what seems to them to be superfluous or valueless, and yet their view-points of value may never come clearly to their consciousness. *c.* This dimly conscious evaluating of view-points of observation extends its influence even to remembering, and in a two-fold manner: indirectly, because we observe in accordance with our evaluation; and directly, in that a similar selection of data takes place also in our remembering where that which seems to be least valuable remains relatively unheeded and is least likely to be recalled. This explains the phenomenon that, in consequence of the extension of our knowledge, a datum may sometimes become

more valuable than it formerly was, and we now attempt with all our power to recall it accurately to memory and fix it there. *d.* Interest or the ascription of values which plays a leading rôle in observational memory and testimony exerts a two-fold influence: advantageous, in so far as observation and memory are promoted in the direction of interest; disadvantageous, in so far as it produces an inclination to make too many statements from the chosen point of view. Apperception may then become so abundant as to stifle observation and remembrance. For this reason, spontaneous testimony usually errs in the direction of the prevailing interests. Stern refers to these as errors of interest; he distinguishes them from errors of indifference which occur in cross-examination, and insists that the two sorts of errors are due to different causes. In his opinion, errors of interest owe their origin to a too broad and many-sided interest which encroaches upon the domain of the actually observed data. On the other hand, the typical errors which occur during interrogation are errors of indifference because they originate in a too slight intensity of interest; they owe their origin to the fact that the observer fails to make a critical distinction between what he remembers and what he does not remember. From this we see how careful one must be in arousing children's interests in particular view-points of observation, because by means of these may be produced an increase in the amount of description at the expense of its accuracy. Here again we find that the essential thing is not merely to inculcate a point of view of observation, and to arouse the child's interest in it; the chief desideratum consists in inculcating a proper method of utilizing the point of view. But this in turn depends chiefly upon two factors: the establishing of a point of view with adequate security, and holding to it persistently throughout the analysis of the observed datum. To these two factors

may be added a third: When the preferred point of view is chosen we must learn to make a critical discrimination between the objective datum and our subjective contribution, between the component which we actually remember and the component which is a subjective supplement to the remembrance.

3. There is still a most important question to be considered. In what manner do imagined components most readily come to preponderate over observed and remembered components? Rodenwaldt has justly remarked that, quite apart from the circumstance as to whether distinctively suggestive questions are asked, the mere interrogation itself constitutes a suggestion. Hence when observational noting is used in the school-room it is essential to bear in mind that even the form of the questions themselves may be very significant. Every question of the teacher exercises a certain suggestive influence upon the pupil, an influence which may be conveyed through vocal inflection, through the grammatical form of the question, etc. Stern finds that the introduction of a "not,"—for example: "Was there not a stove in the picture?"—constitutes the essential form of suggestive questioning. We know also from the experiences of Stern, Binet and Henri, and others, that children show different types of suggestibility. An individual of one type is led by the suggestive question to correct his description, another hesitates in his description, another is inclined to modify his description in the direction of opposition to the suggestion, and still another allows himself to be misled into giving a false description. All of this must be taken into account in teaching by means of observational noting.

4. Interest in what is observed is by no means exclusively a practical interest; a very strong theoretical interest also makes itself felt. Regarding this point, my interpretation of

Stern's results is somewhat different from that given by Stern himself. We find that those features which contribute to an understanding of the picture are especially observed in order that they may be elevated to view-points of observation and that they may be remembered better in consequence of this; while, on the other hand, that which is unessential for the understanding of the picture and the treatment of the situation is readily overlooked. This explains the remarkable phenomenon that the dog is frequently omitted from the list of chief objects, although children have, as a general rule, an especially great interest in animals. The dog is not necessary for an understanding of the general situation,—the evening meal of the peasant family. In experiments where pictures were drawn from memory I have repeatedly found that that which is not necessary for an understanding of the situation is very frequently ignored. This shows that attention is not by any means controlled exclusively by practical but also by theoretical interests. We attend to that which makes things comprehensible to us, and to that which seems to be of value to us.

5. In addition to these chief points, certain subordinate conclusions which have pedagogical significance may be drawn from these experiments. For instance, failure to note colors indicates that the color-sense is trained in an extremely defective manner in modern teaching. Stern's results show that in spontaneous descriptions one-sixth of the statements regarding color are erroneous, while in interrogatory reports, one-half are erroneous. Observation of quantitative relations is equally in need of training; children must be drilled in quantitative statement. Descriptions which involve number and quantity remain relatively imperfect even in the adult; and yet our observations of space and time attain definiteness only when subjected to quantitative statement. In the obser-

vation of the temporal relations of actions and movements it is particularly important to train the eye and the attention in the noting of brief and constantly changing processes. Lipmann found that descriptions of conditions contained less than one per cent. of error, while descriptions of actions contained more than twenty-five per cent. of error.

6. We shall quote only one of the results obtained by Stern in his investigation of the correlation between age and efficiency in observational noting. He found that spontaneous observation shows an extraordinary increase in volume with increasing age of the child. Spontaneous description more than doubles in amount between the ages of seven and fourteen, and it increases almost three-fold between seven and nineteen, while the total amount of description increases by fifty per cent. up to the fourteenth year, and in subsequent years does not increase at all. Hence, as Stern says, the increase of spontaneity in observing and noting is one of the most essential characteristics of mental development. Moreover, it manifests itself also in increasing power to resist suggestion,—that is, the more his spontaneous observation increases in amount, the less is the observer open to suggestive influence.

If now we bear in mind how significant for the child is his spontaneous, independent and active observation of what he sees for himself, we shall again realize that the attention may develop of itself in this direction. What it needs is not aid in the discovery of points of view, but rather guidance in the proper and systematic utilization of its point of view.

CHAPTER V

ASSOCIATIVE LEARNING: THE TECHNIQUE AND ECONOMY OF LEARNING

In observational noting we employ sense-perception as the primary and essential means of imprinting material upon consciousness; an acquisition of the content of perception is here the real goal of our endeavor. But in memorization or in learning in the narrower sense, our procedure is wholly different. It is true that the material to be learned is still presented in the form of sensory stimuli; and we may still speak of visual, auditory, motor and other forms of presentation. *a.* But in learning, sense-perception is no longer the essential means employed in the mental acquisition of the material. It is only the external point of contact with the material; and the objects of perception,—the letters and words which we see and hear,—serve only as symbols which designate meanings. They are stimuli which arouse in us a mental reproduction of the meanings which have become associated with them. *b.* Sense-perception no longer serves for an acquisition of contents of perception but contents of ideas, for it is meaning-contents with which we are now concerned. *c.* In consequence of this, sense-perception now fulfils the function not of painstaking observation but only of hasty impression; and we seek to apprehend its content with just sufficient accuracy to insure the arousal of the appropriate ideas. *d.* For this reason, attention is directed not to the letters and words which constitute the contents of perception, but to the meanings which they convey. *e.* In the act of learning, the will is not directed upon the imprinting

of the contents of perception, but upon an understanding and retention of the meanings of these contents. *f.* The memorial result,—the retention and reproduction of meanings, —is dependent not upon a perception of the letters and the words but upon wholly different factors,—upon the understanding of the trains and contexts of ideas, and upon repeatedly running through the series of ideas which the objective symbols arouse in us.

All of this makes true learning a radically different sort of mental function from observational noting. Hence even in the school-room, observational noting is treated as a wholly different sort of task from learning; and in psychological experimentation, also, the investigation of learning is assigned to a special group of experiments to which the rather inappropriate name of memory experiments is usually given. Following the classification of memory functions which we have already made, we shall refer to them as experiments in learning.

Between the observational noting of sensory impressions and the associative learning of coherent contexts of words and ideas there stands, as a transition stage, a function which comes into operation in teaching more frequently than any other,—the immediate retention of trains of ideas in which, as a rule, words serve as bearers and vehicles of meanings. This function comes into operation in the dictating of words, numbers and sentences, in questions, in mental calculations, in every form of discourse and response. These materials must always be held in consciousness until such time has elapsed as is necessary for the apprehension of the context of ideas. As a matter of fact, the chief process involved here is the apprehension of the connected trains of ideas; but this is rendered possible only through the agency of immediate retention, which brings about a fixation of ideas by means of

attention. This activity, in turn, differs from observational noting and from real repetitive learning. It differs from the former in that the attention is not directed upon sense-impressions which are here only a means to the apprehension of trains of ideas; and from the latter in that the intention here is not to produce a memorial result,—permanent retention,—but only a perceptual result,—a mere grasping by apprehension. And whatever memorial result,—immediate retention,—is attained, serves only as a means to an end,—the end being the act of apprehension.

The experimental investigations which have a bearing upon this mental function in pupils have dealt chiefly with the immediate retention of words, letters, syllables, words and numbers, words arranged in incoherent groups, sentences, stanzas and parts of stanzas of poetry, groups of names and dates, lists of words with their equivalents from another language, and the like.

The most suitable method for the investigation of this function is the one which I have already referred to as the "method of immediate retention." It would be better to give it another name since immediate retention is itself the object of the investigation. English authors have spoken of it as "prehension"; and Pohlmann has translated this term "span of memory." I shall call it the method of single memory-span because I am accustomed to think of a span as a spatial extent and not as a process or activity.[1] When we determine how many letters can be retained after a single

[1] Ebbinghaus calls it the "method of remembered items," but this term is misleading, because it conveys the impression that the observer is always called upon to remember isolated items; and we shall see that he much more frequently endeavors to remember the total impression and to retain the items only as component parts of the total impression. *Cf.* H. Ebbinghaus, *Psychologie*, I., 646.

presentation, and carry the test through successively with gradually increasing numbers of letters until the limit of prehension is reached, we may be said to be stretching the memory as though it were a spring, and measuring its span or power of expansion.

The application of the method of single memory span has been developed in various directions. Binet and Henri presented a uniform number of words (seven) to their observers and had them write all that were retained. I have preferred the successive method, presenting three, four, five items, successively and continuing until I reached the limit beyond which the observer could no longer reproduce without error, or until one-third, or one-half of the items were lacking in the reproduction. If it is desired to employ the method in full completeness, all possible methods of presentation must be employed,—auditory, visual, auditory-motor with vocalization by the observer, and visual auditory-motor with vocalization and visualization by the observer, etc.; and various sorts of material must be presented,—nonsense syllables, significant words, numbers, concrete objects, and words of variable meaning,—in order to test the influence of verbal meaning upon immediate retention. Different tests of reproduction must also be introduced,—recognition, comparison with new stimuli, selection, reconstruction of a presented series when the items are re-presented, oral and written reproduction.[1]

Several of the results of these experiments are of value for pedagogy and for an economy of memory. The sort of material presented is of great influence upon immediate retention. In my experiments, nonsense material, particularly nonsense syllables, was retained much less perfectly than material which has meaning; but nonsense syllables were

[1] For a summary of methods of testing memory see A. Pohlmann, *Experimentelle Beiträge zur Lehre vom Gedächtnis*, Berlin, 1906, 2ff.

retained better than mere groups of letters. Children from seven to nine years of age usually have an immediate retention of only two, at most, three nonsense syllables. In order to avoid repetition I shall here mention no other results of these investigations, and shall refer the reader to my later discussion of the efficiency of memory in children. Regarding the pedagogical bearing of these results the following statement may be made. An especially important question to be considered is: In how far is immediate retention aided by meaning, or by an understanding of the material? Binet and Henri found that the retention of words which had been noted as parts of a sentence is very much more perfect than the retention of isolated words. When a list of seven isolated words was presented, only five of them were correctly reproduced, on the average; but of a sentence containing thirty-eight words, which readily fell into seventeen logically connected groups, fifteen groups were reproduced; and of a sentence whose seventy-four words fell into twenty-four groups, eighteen groups were reproduced. In Ebert and Meumann's experiments practiced observers succeeded in correctly reproducing sentences of thirty-six words. In my own experiments with several hundred children in the public schools, I employed, in a first series, simple words of everyday use; and in a second series, unfamiliar abstract terms. The understanding of the meaning of the words proved to have a marked influence upon retention. Words whose meanings were readily understood were much better retained than difficult or unintelligible words.[1]

The method of presenting the material is also of influence. One must be cautious, however, in drawing conclusions as to the effect of presentation in immediate retention, from experi-

[1] E. Meumann, Intelligenzprüfungen an Kindern der Volksschule, *Zeitschr. f. exp. Pädagogik*, I., 1905, 35–101.

ments on lasting retention where real learning is concerned because the process of apprehension operates under wholly different conditions in the two cases. From comparative experiments I have found it impossible to state that any particular method of presentation is, in all cases, the most favorable for immediate reproduction. The advantages accruing to any particular method depend, in part, upon the sort of material presented, in part, upon the ideational type of the observer, and in part, upon the mode of presentation itself. This may be illustrated from the experimental literature. Pohlmann[1] repeated the experiments of Binet and Henri and found that in the presentation of isolated words the tempo of speech is an important factor, especially with individuals of the visual type. We shall see presently that persons who make use of visual imagery in their thinking develop any given train of ideas less rapidly than individuals of the auditory type; and this is especially true when the former are obliged to transform the auditory images of the presented words into visual images. In conformity with this, Pohlmann found that an observer of the visual type is hampered in his visualizing by a rapid auditory presentation of the words.[2] The observer from whom this result was obtained reported the following introspection: "During the auditory presentation of the words I endeavor to apprehend them in visual form also. I do not succeed, however, with more than the first half of the series because they are read to me too rapidly; I usually succeed only with about the first three or four words. In the reproduction which immediately follows, I have more confidence in dealing with these first few words; and I reproduce the latter part of the series solely by means of the rapidly fading auditory image." I have frequently obtained similar introspections from observers of the visual type. We see

[1] A. Pohlmann, *Op. cit.*, 71ff. [2] A. Pohlmann, *Op. cit.*, 73.

from this that in auditory presentation every tempo is not appropriate to every type of imagery. For persons of the auditory type a relatively rapid tempo is more advantageous. For visualizers a slow tempo is necessary if their visual images are to assume distinct and definite form; and only when this condition is fulfilled can their ideation be clear and definite.

Pohlmann devoted a special investigation to the problem: Do individuals actually have accurate and distinct images of the concrete contents of words? He found that this is not invariably the case.[1] This result was to be expected from our knowledge of the psychology of thinking by means of words; for even in ordinary speaking the concrete word-meanings come to us in extremely fleeting and transitory fashion. This question, however, is wholly different from the one mentioned above, namely: Is the retention of words aided by an understanding of their meaning? We may understand the meaning of the words without bringing their concrete idea-contents clearly to consciousness; indeed, in ordinary reading and speaking, and especially in rapid reading and speaking, we normally have the sense of the words distinctly before us although the detailed idea-content is present only in vague and fleeting fashion. The possession of a clear understanding of the meaning of a word presupposes only that we have made the verbal meaning clear to consciousness at some former time; it subsequently comes up in more and more vague form. And what we have present to consciousness is only the logical and associative relations of one word to others.

A further pedagogical significance attaches to a characteristic feature of immediate retention, which consists in the fact that all verbal and ideational material which has been heard but once soon disappears again from consciousness;

[1] A. Pohlmann, *Op. cit.*, 77 and 79.

and indeed under certain circumstances it is almost immediately forgotten. If we dictate to an observer a series of words whose number is about the limit of his capacity of immediate retention, and if after the presentation there should occur a distraction, it frequently happens that the whole list of words is forgotten forthwith.

The rapidity of this forgetting is increased by various factors which occasionally coöperate. Words which have been presented orally disappear more rapidly from consciousness under the following circumstances: *a.* When they have not been clearly apprehended. Words which have not been heard distinctly or which are not accurately transformed by the observer into his own typical sort of imagery disappear most readily from consciousness. *b.* When the meaning of the word is not at once apparent to the observer. Thus it frequently happens that dull pupils cannot answer questions for the simple reason that they do not fully understand the words employed; and in consequence, their immediate retention is unable to hold the question in consciousness. On account of this fading of their ideas from consciousness they find it impossible to reflect upon the question. This constitutes a reason for the frequent repetition of questions and for the asking of incidental and subordinate questions. Müller and Pilzecker have shown that homogeneous reproduction-tendencies reinforce one another. This furnishes a psychological justification for the repeating and the supplementing of questions by the teacher, because these two expedients reinforce and strengthen the reproduction tendencies possessed by similar verbal material and similar idea groups. *c.* The effect of fatigue must also be mentioned here. The compass of immediate retention decreases rapidly when the observer is mentally fatigued, a phenomenon which is due to his unfavorable physiological disposition. I once had my own im-

mediate retention tested at a time when I was very much fatigued, and was obliged to discontinue the test because the compass of my retention was so abnormally small.

The amount of material which is presented for immediate retention is an influential factor in determining the individual's capacity. The presentation of too many letters[1] or words may confuse the pupil and give rise to an inhibition of attention, which in turn brings about a complete forgetting of the presented data. Hence it frequently happened that pupils who retained the complete list of seven words were able to reproduce only one or two words when the list was increased to eight. In such cases the attention follows the presentation only up to a certain point; then the observer suddenly becomes aware of the fact that he is unable to follow so many words. And the consciousness of this fact immediately has a debilitating effect upon his retention, and even drives out the words which he has already imprinted upon his memory. This is a phenomenon which has frequently been referred to as retroactive inhibition.

A further question which is equally important for pedagogy and for psychology concerns the influence exerted upon immediate retention by the mode of presentation employed. The pedagogical importance of this question is due to the fact that the teacher has to deal at every turn with the influence of different methods of presentation; and this influence may vary greatly with variation in the sort of material presented, and in the age and endowment of the pupil. The question is important psychologically because it shows us in how far the internal attitude and subjective procedure of a person, particularly his operations with different memory elements, are influenced by the mode of presentation or by

[1] E. Meumann, Intelligenzprüfungen an Kindern der Volksschule, *Zeitschr. f. exp. Pädagogik*, I., 1905, 35–101.

the sort of stimuli employed. It cannot therefore surprise us when we learn that numerous authors have turned their attention to this problem. Various points of view must be taken into consideration in discussing the methods of presenting material for immediate retention, as for example, the point of view as to whether it is better to question or to develop, as to the effects of description and narration, etc. These questions concerning the form of teaching have scarcely been approached as yet in pedagogic-psychological investigations. Experimenters have been concerned rather with another point of view,—that of "mode of sensory presentation," or more strictly speaking, with the question: What effect has the dominant sort of stimulus, by means of which the material is presented to the pupil, upon his capacity to reproduce immediately? Several possibilities come in for consideration here:

1. The several parts of the material may be presented simultaneously or successively, but, since the auditory organ receives all of its stimuli successively, this distinction can be carried through only in the case of visual presentation, and, to some extent, with tactual presentation.

2. The material may be presented to one or to several senses simultaneously. It may be perceived simply by means of the visual, or the auditory, or the tactual, or the kinæsthetic sense. Or it may be presented simultaneously to the eye and the ear by a method of exposing and pronouncing; simultaneously to the visual and motor senses, by having the observer make appropriate muscular movements of speaking, writing, etc., during the exposure; simultaneously to the auditory and motor senses, by a combination of pronouncing by the experimenter and by the observer; simultaneously to the visual, auditory and motor senses, by a combined exposure and dictating by the experimenter and pronouncing by the observer.

3. We must not fail to bear in mind that the method of presentation does not by any means determine the method which will be adopted by the observer in his perception and apprehension of the material. This latter is a joint product of the mode of presentation and of the ideational type of the observer. If we present any material orally to a number of pupils, only those who belong to the pure auditory type will apprehend it in terms of auditory images; the visualizers will, so far as possible, transform it into visual images, and the observers who belong to the auditory-motor type will pronounce the words to themselves during the presentation.

One of the chief obstacles to an accurate investigation of the effect of different modes of presentation is due to this circumstance; and it is an obstacle which is exceedingly difficult to overcome in class-experiments in the schools. In such experiments, a variety of ideational types is always present; and hence we can never know to what extent the method of acquisition and of reproduction conforms with the method of presentation. The mode of acquisition and reproduction may perhaps always be regarded as a compromise between the ideational type and the mode of presentation.

A second difficulty in these experiments is solely a matter of method. The experimenter always finds himself confronted by two alternatives in his choice of method. He may present his material exactly or approximately as is done in the ordinary work of the school-room; or he may arrange to restrict his observer to the use of but a single sense-department in the acquisition and retention of the material. In the former case, we find it impossible to isolate the mental effect of the various sorts of sensory presentation in any definite fashion, because when we dictate the list of words we leave the observer free to pronounce them to himself or not as he will; hence we have no guarantee that particular mental

processes are isolated by the pupil in any such fashion as the experiment demands. If the second alternative be chosen, the presentation shows a wide departure from the ordinary procedure of the school-room; but an insight is obtained into the manner in which particular sensory-motor processes operate in memory. The former method of conducting the investigation, if employed exclusively, has the advantage of being able to show us how the several modes of presentation really affect persons of different imaginal endowment; but it admits of no unequivocal interpretation of the experimental results. The second method assures an unequivocal interpretation, but it leaves us uncertain as to whether our findings may be applied to the practical work of the school-room. It seems to follow, then, that the only way to reach a definite solution of our problem is to employ a combination of the two modes of procedure. Segal[1] has recently attempted to make a complete separation between the various "sense-memories" in different methods of presentation; but I cannot wholly accept his results for the reason that his observers were too few in number. Moreover, I have myself employed Segal's method on numerous occasions, and shall speak of it elsewhere. Segal is the only author who has published any experimental data dealing with the behavior of the different ideational types when material is presented to them which may be reproduced in various ways. How, for example, does the visualizer proceed when he is asked to reproduce purely auditory material, such as simple tones? What is the procedure of an individual of the auditory type when he is called upon to reproduce colors? How do the two of them proceed when they are obliged to retain and to reproduce words which have been presented by

[1] J. Segal, Ueber den Reproduktionstypus und das Reproduzieren von Vorstellungen, *Archiv. f. d. gesamte Psychol.*, XII., 1908, 124–236.

various methods and which may be reproduced in various forms? These preliminary questions must be answered before we can reach a definite interpretation of the experimental findings which deal with the various methods of presenting memory material.

All of the investigations which have been undertaken in this field suffer from either of the defects which we have mentioned; and numerous other objections may be urged against them. An insufficient number of observers has been employed; and the investigations have been limited, in a one-sided fashion, to collective (class-room) experiments. Only by combining the class experiment with the individual experiment can we ever attain to a satisfactory interpretation of results.

The most extensive experimental attempt to answer our questions with school-children has been made by Pohlmann. This investigator employed familiar significant material,—two-syllable names of concrete objects, and concrete objects themselves. He made use of six methods of presentation: *1.* He presented the objects visually,—key, funnel, sugar, purse, mirror, candle, etc. *2.* He presented the objects visually and at the same time pronounced their names. *3.* He pronounced the names alone. *4.* He presented the names visually. *5.* He combined the visual and the auditory presentation of the names. *6.* He combined the visual presentation of the names with pronunciation by the observer. Ten words and ten objects were employed. His observers were pupils from nine to fourteen years of age, ten of each age, making a total of sixty observers. The stimuli were presented but once; and they were reproduced immediately in writing. The experiments were, therefore, an investigation of immediate retention.

Pohlmann found that the retention of objects is much

more successful than that of words,—a phenomenon which has a direct bearing upon the use of demonstration material in teaching. The results with auditory presentation were, on the average, much better than with visual presentation; and auditory-visual-motor presentation gave the poorest results of all. Pohlmann adds: "Under the conditions of my experiments, the participation of the motor function influenced the results unfavorably, for the purely auditory-visual method of presentation was much more effective."

Data obtained from such group investigations as these are of relatively slight significance because the much more important individual results are obscured by being incorporated into a total mass. These results show, however, that the superiority of auditory presentation holds only in the lower classes of the schools; beyond the intermediate classes visual presentation gradually gains the ascendency and in the upper classes the relations are reversed, visual presentation being more advantageous here.

This state of affairs is undoubtedly a product of the prevailing methods of teaching, because instruction is addressed more to the ear in the case of younger pupils, while, in the case of older pupils, the visual sense is more concerned. Pohlmann[1] also investigated the comparative retention of words and of concrete objects, for intervals of twenty-four hours and three days. Here again it turns out that the best results are obtained with objects, words being forgotten much more readily. For the retention of words, the visual-auditory-motor is again the least effective mode of presentation, and the auditory-visual the most effective; the purely auditory method stands intermediate between these two extremes, with visual presentation but little superior to the auditory-visual-motor method.

[1] A. Pohlmann, *Op. cit.*, 150–157.

Pohlmann concludes from these results "that the weakening effect of time is considerably greater in the case of verbal than of concrete presentation," an inference which is not only justified by his results, but which is also of practical significance to the teacher.

When the same material was presented three times, instead of once, as in the experiments described above, the best retention was found to follow from auditory-visual and purely auditory presentation.

A wholly different state of affairs is revealed by the use of unfamiliar and non-significant material. Pohlmann investigated the immediate retention of nonsense syllables and found that visual presentation now has a decided advantage over all other methods, a result which my own experiments have confirmed. I believe that the chief reason for this is to be found in the fact that in the purely auditory apprehension of unfamiliar words it is difficult to analyze the syllables into their phonetic elements. The sound elements of words are much more arbitrarily constituted than the visual elements; and moreover the phonetic analysis must here be carried over into the visual elements of the written words. Pohlmann believes that auditory presentation makes a stronger appeal to the attention; and that when articulation is clear and distinct, the auditory word is more "penetrating" than the visual. I have no faith in this doctrine of "penetrative power" of sense impressions, as formulated by G. E. Müller; it has received no confirmation from the experimental investigation of attention.

In additional experiments, where numbers were employed as stimuli, Pohlmann again found visual presentation to be more advantageous than auditory.

When he varied the rate of presentation it was found that an increased rapidity of pronunciation weakens the retention

considerably; but the relative effects of the several modes of presentation were here but little changed.

Pohlmann obtained a remarkable result in his experiments in a girls' school, where visual presentation proved to be more advantageous even for familiar material. Does this indicate that girls (and women) are more dominantly visual than boys? Or is it due, as Pohlmann believes, to the fact that a more frequent appeal is made to the visual sense by teachers in girls' schools?

This investigator's results throw light upon the differences which are due to successive and to simultaneous presentation of visual material. Muensterberg and Bigham had found that simultaneous presentation is more favorable to reproduction; while Hawkins reports that "young pupils are not able to imprint so much material upon memory in simultaneous presentation as in successive." Pohlmann[1] discovered in agreement with Hawkins, that "average results show successive presentation to be, on the whole, more advantageous for memory." This is probably to be explained from the fact that the function of attention was regulated better here than where several stimuli were present at the same time.

Pohlmann's experiments are unquestionably of great pedagogical value. Above all else, they show us the importance of methods of presentation for different sorts of material. They do not, however, furnish a final verdict concerning our problem, because they fail to provide for a complete separation of the component processes which constitute apprehension. With regard to this matter, Pohlmann misinterprets his experimental findings. Thus he maintains, for instance, in opposition to W. A. Lay, that an inhibition of vocalization by holding

[1] C. J. Hawkins, Experiments on Memory Types, *Psychol. Review*, IV., 1897, 292. A. Pohlmann, *Experimentelle Beiträge zur Lehre vom Gedächtnis*, Berlin, 1906, 181.

the tongue pressed against the teeth is a distracting factor. I am convinced, as a result of numerous controlled experiments, that pupils become accustomed to this unusual condition after a few experiments; and with most pupils it does not constitute a distraction. The final verdict as to the value of different methods of presentation cannot be rendered until the conditions of experimentation, which I mentioned above, are fulfilled. Regarding Pohlmann's own pedagogical inferences it may be said that, in agreement with myself, he holds that in the treatment and evaluation of pupils their ideational types must be taken into account, but not in teaching itself, because every pupil should be trained to work with methods of presentation which are not the most convenient for him. And since visual presentation has been shown to be especially advantageous with unfamiliar words, Pohlmann correctly infers that visual presentation has great significance in the teaching of foreign languages; and that the purely auditory method or vocal method, which is now being recommended, is one-sided and unwarranted.

Let us now consider real learning by means of repetition, or learning in the narrower sense, together with its conditions and its technique.

The whole doctrine of the conditions and methods of learning is based upon the experimental investigation of memory. These investigations have undertaken to make a quantitative determination of memorial function in order by this means to obtain a clear insight into the conditions which are favorable and unfavorable to memorial activity. There are two chief starting-points from which the function of memory may be investigated. *1.* We may investigate learning in the narrower sense of learning by rote,—or, to express it in psychological terms, the formation of lasting associations between ideas, and chiefly between verbal ideas. In our attack upon

this problem, we determine what is the effect of association upon acquisition and retention; that is, the effect of learning is tested and determined quantitatively in various cases,—and we investigate the learning process itself, or the formation of associations in the process of learning. Only by means of such a quantitative determination can we compare the influences exerted by the various factors and conditions of learning; for so long as we are restricted to mere description,—and description in such indefinite terms as "better" or "not so good,"—of the result of learning or the accuracy of retention, an exact comparison of the results of the various conditions of learning is impossible.

Not only is it possible to investigate the reproduction which is due to a process of learning, but the reproduction of those ideas which are not the product of a deliberate formation of associations,—the free flow of ideas,—has also been opened up to experimental investigation. The reproduction of the free flow of ideas has been investigated by Galton, by Wundt and his pupils, by Ziehen, and more recently by the Würzburg group of psychologists and by the present writer. But it is to Ebbinghaus that we owe the first development of the methods by means of which learning,—the real function of memory,—is investigated experimentally. Notwithstanding many improvements which have been added to the methods of Ebbinghaus, especially by G. E. Müller and his school, the measurement of memory remains essentially the same in principle to this day. And it was Ebbinghaus, too, who obtained the pioneer results in the experimental psychology of memory.[1]

The methods which Ebbinghaus introduced for the investigation of memory may be made clear by the following considerations. In the investigation of any memory function,

[1] The reader is referred to the Bibliography at the end of this volume.

such as the memorization of any simple material, we must fulfil two prime conditions. On the one hand, the external and internal conditions of the act of learning must be kept as constant as possible throughout, and they must be under the control of the experimenter; at the same time, they must be so chosen that not only the conditions themselves, but also the effect of the learning may be capable of being determined quantitatively. On the other hand, the material to be learned must present a uniform degree of difficulty throughout its whole content. If, for example, we wish to determine what is the relative influence exerted upon the learning and retention of a poem by number of repetitions and by concentration of attention, and particularly to what extent an increased concentration of attention may result in decreasing the number of repetitions, it is necessary that we make a comparison of the processes of acquisition in at least two cases. In the first case, we heap up the repetitions and pay no particular heed to the intensity of concentration; in the second case, we endeavor to limit the repetitions to as small a number as possible, striving to compensate the decrease in number of repetitions by an increased intensity of concentration. We shall see later that the effect upon memory is different in the two cases. But if we wish to determine exactly what part of the resulting effect upon memory is due to attention and what to number of repetitions, it is absolutely essential that all of the internal and external conditions of learning, save only the two which we have varied deliberately, should have remained constant throughout. Or in other words, all other factors of learning excepting only these two must remain unchanged throughout. For not until these conditions have been fulfilled can we say, for instance, that the better retention in the case of the more frequent repetitions is to be regarded as a product solely of this one changed condition

of learning. For this reason, the stanzas of poetry must have been equally difficult in the two cases; because if we do not fulfil this requirement, it is wholly impossible to determine exactly what was the effect of the changed condition of learning. If, then, we are to obtain really comparative results, it is essential that we should employ material which presents a uniform degree of difficulty throughout. The internal conditions under which the observer works must also remain constant. It is necessary therefore to preserve a constancy and uniformity of bodily and mental vigor, of psychophysical disposition, of inclination to learn, of emotional tone, of attention, and of interest in the material. If this should prove to be impossible, we must record the fluctuations and subsequently attempt to evaluate them and to utilize them in the interpretation of such variations as may have occurred in our results. Variation in internal conditions and particularly the variable influence of distractions may be excluded by an appropriate arrangement of our experimental conditions. By means of the latter, we are able also to control the external conditions of learning. For this reason, experiments should always be made at the same hour of the day, in the quiet of the laboratory, and with only the experimenter and the observer present. One of the most important internal conditions consists in the fact that the degree of training or skill in learning the material selected should be the same in every observer who takes part in the investigation. For this reason, it is customary to devote a certain time to preliminary practice before the comparative experiments begin, and in this preliminary period to train the observer until the number of repetitions required for a given task of learning has become constant, from which we may infer that he has reached a state of maximum or approximately maximum practice.

As a result of his many years of experience in experimentation, the psychologist is able to fulfil most of these requirements. For instance, a constancy of attention may be facilitated either by habituating the observer to the conditions of the experiment, or by recourse to certain expedients in experimental procedure which aid one in obtaining a maximum and uniform concentration of attention. If we arrange to have the learning done under adverse circumstances, for example, by exposing words and syllables for only an exceedingly brief period of time, the observer must either concentrate his attention uniformly to its highest pitch in successive exposures, or he will completely fail to perform the task assigned to him. To be sure, our mental life is subject to changing conditions of such extreme complexity that we cannot hope in every instance to obtain exactly the same results from identical experimental conditions. For instance, if after having met all the requirements prescribed above we ask the observer to memorize stanzas of poetry on different days, and if the stanzas are selected as carefully as may be, to insure a uniform degree of difficulty, we shall still succeed only in very rare instances in finding that any given observer requires exactly the same amount of time and the same number of repetitions in his various memorizations.

This obstacle is overcome by frequently repeating the same experiment and by striking an average from the results of all the experiments. We repeat each experiment on many different days, and take the arithmetical mean of the various experimental findings, or one of the other mean values in current use. It is well to bear in mind that such an average is justified only when the particular cases from which it was obtained "are effects of the same system of causes" (Ebbinghaus); but this identity of coöperating causes is just what is provided by our experimental conditions.

Among the external conditions of memory measurement the choice of memorial material is of prime importance. *1.* The materials employed in any series of measurements must be of equal difficulty throughout. If we compare one stanza of a poem with another, we shall always find differences in the construction of the sentences, in the diction, in the uniformity with which the logical context is distributed over the whole stanza, and the like,—variations which constitute a different degree of difficulty in the memorization of each stanza. This inequality is even greater in prose selections, because these are still less uniform in their structure. Hence, strictly speaking, we should be obliged to perform our experiments in memory with an ideal material which is free from these irregular variations. *2.* The material which we employ in the investigation of memory must, however, fulfil yet another condition; we must be able to manufacture it in great quantities because most memory experiments extend over weeks and months, and demand a new and equally difficult material for each day's experiments. *3.* The material must be capable of accurate quantitative gradation, because otherwise the memory function would not be quantitatively determinable in particular instances. *4.* The material must be of such a character that the errors made in reproducing it may be enumerated, added, compared and otherwise submitted to systematic mathematical treatment. This requirement also is lacking in most school material, such as poems, prose selections, lists of words, etc. And finally, *5.*, the material must, so far as possible, be so constituted that its elements have not already entered into associations with one another, in order that all associations may be formed during the course of the experimentation itself.

It was such considerations as these which led Ebbinghaus in 1879 to the conviction that all memory experi-

ments should deal with an artificially constructed material which may be built up in accordance with a perfectly definite plan.

A sharp distinction must be drawn between material which is a purely artificial product and that which results from the artificial transformation of such significant material as is to be found in the school-room. As material of the former sort Ebbinghaus chose nonsense syllables, which he constructed by inserting a vowel or diphthong between a pair of consonants, care being taken to avoid similarity with familiar words of one's own or of a familiar foreign language. Such material is illustrated by the following syllables: sef, naz, kug, rix, gan. Nonsense syllables such as these seem to provide ideal conditions for memory experiments for the reason that equally long series may be assumed to be equally difficult to learn (in experiments, series of twelve syllables are usually employed), and that by following the scheme of construction suggested by Müller and Schumann a large supply of these syllables may be prepared. G. E. Müller has composed 2,304 different syllables which are suitable for use. In general then we may say that the difficulty attaching to a series is measurable in terms of its length alone; and that therefore the number of syllables in the series expresses the amount of learning that is to be done. We shall find later that this statement must be qualified. Then, too, nonsense syllables do not possess associations with other words as do the ordinary words of the language. Every error made in reproduction may readily be expressed quantitatively because of the uniform construction of the syllables. Moreover, the syllables may be so chosen that difficulty of pronunciation is equally distributed over the various series, similar sounds which might aid memory in unequal degree being avoided. The syllables have no internal bond of union, so that they may be assumed to make

a constant and uniform appeal throughout to attention, emotion and interest.

And yet even this material is defective in certain respects. The observer's associations still read meaning into the syllables occasionally; and a series in which this takes place is, of course, more readily learned. For several reasons, which cannot readily be explained, a series of nonsense syllables is sometimes found to be more easy or more difficult than usual. But we may observe that all these secondary expedients for retention, such as the formation of significant associations, gradually and invariably retreat to the background as the experiment progresses, and that most observers learn in a mechanical fashion. This material has only a modicum of meaning. Hence it can be used only for the investigation of mechanical learning; it is not appropriate for an investigation of that type of learning which is aided by meaning. It is important, however, to determine the fundamental laws of memory for even this simplified type of mechanical learning. Indeed when a relatively simple material which can be learned mechanically is employed in experiments, the operation of the reproduction-tendencies of ideas appears even more distinctly than when significant material is employed, because the various reproduction-tendencies may cut across one another and impede one another in the latter case. We shall see, however, that the extension of memory experiments to significant material has recently been found to be possible in increasing degree.

Ebbinghaus's[1] procedure with nonsense syllables was as follows: Each series was memorized by repeatedly reading it aloud, from beginning to end, as a whole,—never in parts. Meanwhile he permitted a free alternation between reading and reciting from memory, for he experimented upon himself

[1] H. Ebbinghaus, *Ueber das Gedächtnis*, Leipzig, 1885.

alone. He controlled the rapidity of reading and reciting by speaking in a tempo of "150 beats to the minute," having previously practised this tempo with a metronome or a watch. He memorized rhythmically, grouping the syllables by threes and by fours and pronouncing the first, fourth, seventh, etc., —or the first, fifth, ninth, etc., with a moderate accentuation. He continued to learn until he was able to recite the series without error, stopping when he felt that he had memorized the material. We shall discuss his results presently.

His initial experiments suffered from numerous defects, which he himself recognized in part. The first defect consisted in the fact that he served both as learner and as experimenter. In consequence of this it was possible for preconceived opinions to influence his results; and the conduct of his experiments was also rendered more difficult. Nor were his lists of syllables free from objection. He determined to leave the construction of his series to chance; accordingly he wrote the syllables upon cards, shuffled the cards and selected at random from the pack. It must have happened that significant syllables appeared occasionally, or that successive syllables were similar in sound, etc. Then, too, Ebbinghaus simply read off the series of syllables which appeared upon the cards. This made it possible for his eye and his attention to sweep back over the parts which he had already read. Now, if the learner is allowed to glance back over his list of syllables, it becomes impossible to count the actual number of repetitions employed. An accurate enumeration of repetitions is possible only when a purely successive presentation is employed, for only then will the recorded number of repetitions represent the actual number of single readings; G. E. Müller was led by Ebbinghaus's own experiments to improve the experimental procedure in many ways.

During the years 1887 to 1892, Müller, in collaboration

with Schumann, worked out a modified method. These two investigators always employed a procedure in which an experimenter performed experiments upon an observer. The experimenter constructed the series of syllables, superintended the experiment and recorded the results; the observer was required only to learn the syllables and to report his introspections. Müller and Schumann also introduced "improved and refined series of syllables," or normal series. In order to exclude syllables which are difficult to pronounce they made use of only sixteen initial consonants, twelve vowels (and diphthongs), and twelve final consonants. From these letters they constructed 2,304 nonsense syllables; and of these, ninety-four were subsequently discarded because of difficulty of pronunciation, so that a total of 2,210 syllables was employed in the investigation. All distracting factors within the series were eliminated, as, for instance, the combination of successive syllables into significant words. They also aimed[1] to introduce uniform conditions of learning by endeavoring to compel a purely successive reading by means of an ingenious device. This consisted in writing the syllables with uniform spacing, upon bands of paper, passing the paper around a drum and rotating the drum at a uniform rate of speed by means of an accurate clock-work device. A screen was set up before the drum; and an aperture in the screen, at the height of the observer's eye, enabled the syllables to be read, one at a time. During the slow rotation of the drum the syllables came into view successively; and in consequence of this arrangement the observer was prevented from seeing several syllables at a time and imprinting them simultaneously. This arrangement is very important. When we memorize by reading syllables from a sheet of paper which

[1] The procedure which was followed in constructing the syllables is described in Appendix I. at the end of this Volume.

lies before us, we never learn in a purely successive or continuously progressive manner. The eye sweeps over a great part of the material, and the regard hastens on in advance of the vocalization, or sweeps back again to what has been read; and irregularities in the behavior of the learner are thereby introduced.

Müller and Schumann also employed rhythmic learning consistently throughout, usually making use of trochaic rhythm; and finally they obtained a more reliable measurement of retention, of forgetting, and of the amount of work done in learning. Ebbinghaus had, in the main, determined only the time spent in the initial learning and in re-learning. Now if the reading had been done at an absolutely uniform rate, and if the pauses between the several readings had been exactly equal, his unit of measurement would have sufficed; and the number of repetitions could be computed from the time expended in learning. But it is impossible to obtain such a uniform procedure on the part of the learner; and it is always better, therefore, to take the number of repetitions as a measure of learning and retention. Various means of measuring memory function may be employed, however; and each of them has its own significance.

The act of learning may be measured either in terms of the learning-time, or in terms of the number of repetitions which are necessary to produce a first errorless recitation, or in terms of the amount of fatigue present in the observer after the learning has been completed. As our unit for measuring retention, we may take either the number of errors in reproduction, combined with the time which has elapsed before reproduction is begun; or we may determine the saving of time and of repetitions on re-learning; or we may determine the learner's capacity to specify what syllable follows any syllable named by the experimenter. The former method

is called the Saving Method (*Ersparnismethode*), the latter the Method of Correct Associates (*Treffermethode*). Each of these methods has a somewhat different significance attaching to it. By means of the saving method we are able to show that traces of the after-effect of the learning are present in memory even when a free reproduction is no longer possible. For example, a list of twelve or fourteen nonsense-syllables is usually so far forgotten after twenty-four hours that very few persons can recall it without error. But if the observer is set to re-learn the series we find that his saving of repetitions is in most cases fairly large, frequently eighty to ninety per cent. This method enables us to demonstrate that the after-effect of learning still persists after weeks and months, even when free reproduction is no longer possible. The method of correct associates has a different object in view. If after the lapse of twenty-four hours we name the first, third, fifth, or seventh syllable of the series, and have the observer reproduce the even-numbered syllables,—the other member of the pair of syllables, in each case,—we are clearly not determining whether the series as a whole is still clinging to his memory. This method shows us the stability of the association between syllable and syllable. Moreover, the method of correct associates furnishes us with a means of determining how the concentration of attention was distributed over the series during the act of learning. If we employ this method after five readings of a series, we discover which syllables are already imprinted and which are not. We frequently find that the beginning and the end of the series can be correctly reproduced before the middle part of the series is learned. From this we may conclude that attention is most intensively concentrated at the beginning and at the end of the learning, while it relaxes at the middle of the series.

Müller and Pilzecker subsequently (1892 to 1900) intro-

duced yet another method of measurement which they call the method of time and correct associates. Here they measured the time which elapses "between the apprehension of the presented syllable and the reproduction of the associated syllable," *i.e.*, they employed the method of correct associates, and at the same time measured the time required for reproduction. The object of this measurement was to determine "whether those associations which have greatest strength, and which yield the greatest number of correct associates require, in general, the shortest reproduction-times." It is easy to see that the time which an observer requires for the reproduction and the pronunciation of the associated syllable must increase when the reproduction falters; and it would be of psychological interest to determine whether brevity of reproduction-time is an unequivocal criterion of the stability of the association between two syllables.

Müller and Pilzecker also introduced an improved method for presenting the syllable upon whose appearance the observer is required to reproduce another syllable. They fastened the paper band carrying the syllables around a twelve-sided drum. A screen with a small slit hid the whole drum excepting the syllable which appeared behind the slit. By means of an electro-magnetic device the drum could be rotated through thirty degrees to expose a new syllable at the instant when a shutter in front of the slit was opened and the syllable was exposed to the observer. An electric contact set a chronoscope into motion; and at the first instant of the observer's pronunciation of the associated syllable the chronoscope was stopped by means of a lip-key. This arrangement enabled the experimenter to determine the reproduction-time for the pronunciation of the associated syllable.

The experimental methods which have been described were considerably modified for the presentation of significant

material. Before I describe these modifications, however, let me discuss the results of the experiment whose method has just been outlined. An experimental investigation, from the very nature of the case, begins with the simplest and most elementary relations. A determination of these relations furnishes a foundation for the treatment of more complex problems. But we begin with the simplest case for the reason that we must endeavor to measure the part played by each component cause in the complex system of causes of mental functions; and also because it is only in the case of simple processes that we can adequately observe the causes which are at work. Even when we proceed in this fashion, we find that a certain factor which is difficult to control interferes in every series of experiments, namely, the individual variation of the observer. Earlier psychologists usually ignored these individual differences, treating them as special sorts of deviation from normality, or even as "errors." In recent times, however, these individual differences of observers have come to be an important feature in psychology. They furnish us with a means of tracing differences in individual endowment to their fundamental psycho-physical conditions; and this brings us nearer to the problem of the origin of human individuality. Sometimes these differences can be reduced to certain constantly recurring "types"; and when we shall have succeeded in determining these mental types, we shall have paved the way for an interpretation of the results of our psychological experiments.

The problem of typical differences is of paramount interest for pedagogical practice; it alone can furnish us with a definite basis for the characterization and treatment of pupils. It is for this reason that I begin my discussion of investigations of memory with a description of the individual differences which we find in the memorial function of both adults and children.

An analysis of these differences which will reveal the most elementary and fundamental properties of intellect will at the same time furnish a foundation upon which to base all of our subsequent discussions.

1. *Memory Types, Learning Types, and Ideational Types*

Anyone who has conducted experiments in memory upon even a small number of individuals of approximately the same age must have been struck by the great differences of memory function of his observers. The fidelity of retention, the length of the interval after which a trace of the learned material still persists, the rapidity with which forgetting begins, the rapidity of learning itself, and the like,—all of these vary between wide limits in different individuals. In the main, however, there are two fundamental differences which seem to be the most important practically: the different rapidity of learning, and the difference in fidelity and permanence of retention. It is possible that the cause of the latter is to be found in the former. Let us, therefore, begin with differences in the rate of learning in different individuals. These differences are exceedingly great; and they give rise to memory types, which are wholly different in their modes of operation. Learners may, in general, be classified into two groups: rapid learners and slow learners. The rapid learner is characterized not merely by his ability to reach his goal,—errorless recitation,—more rapidly; but his mode of learning, the effect of his learning upon retention, his mode of relearning, his span and adaptation of attention, his curve of forgetting,—all of these are different from those which one finds in the slow learner. In a word, the rapid and the slow learner each represents a characteristic mental type which may be determined experimentally in its essential attributes.

When memory experiments are made with nonsense-syllables, the rapid learner is, of course, revealed by his ability to acquire an errorless reproduction in a shorter time and with fewer repetitions. Let us illustrate this phenomenon by the citation of numerical results which will also show the magnitude of the difference between the two types of learner. In one of my experiments, a slow learner, *Z.*, required 56 repetitions in order to memorize 12 nonsense syllables, while a rapid learner of approximately the same age, *P.*, required only eighteen repetitions for the memorization of the same series. After a month's practice, *Z.* required 25 repetitions for a similar series, while *P.* required 6 repetitions for this similar series. *F.*, a rapid learner, required 26 repetitions at the outset, and 8 repetitions after 36 days' practice. *W.*, one year older than *F.*, learned this same series with 20 repetitions at the beginning, and with 12 repetitions after 36 days' practice. In children, these types appear no less distinctly and, contrary to expectation, they remain constant even with different sorts of material. The typical differences persist no matter whether the material to be learned is of a significant or a meaningless sort, although with significant material the two types no longer differ so widely, because interest and special aptitude for certain materials play a part in learning. The individual who learns nonsense-syllables slowly is also slow in his acquisition of poems, prose selections, vocabularies, dates, etc. G. E. Müller, to be sure, insists that with poems he is able to concentrate his attention much more rapidly than with nonsense-syllables, but the very reverse is true of other individuals. But these are differences which do not mask the learning type. We shall see that there is only one factor which is able to conceal nearly all of these differences in learning, and that is practice continued through many years. This has a levelling effect upon all of the mental functions; and it

is able to obliterate almost all differences of connate endowment in the domain of memory. In order to show that these typical differences are present even in children, we may mention that *B.* (thirteen years old) learned a stanza of poetry with an average of eight repetitions, while *M.* (same age) learned the same stanza with twelve repetitions; and of course the learning-time is also considerably shorter for rapid than for slow learners. In these determinations of the number of repetitions, and of their effect upon the first possible reproduction, we see at once another characteristic of the rapid learner. He also begins sooner to forget, so that we may formulate the rule: He who learns rapidly also forgets rapidly. In our experiments it was found that *P.* was unable to reproduce a series of syllables two minutes after learning it; hence, as rapid learners usually do, he requested that he might be allowed to begin his recitation immediately after he had attained the "feeling of certainty." The typically rapid learner, then, is usually a rapid forgetter, and his manner of reciting during reproduction reveals the rapid onset of forgetting, the reproduction being restive and in more rapid tempo than the learning. This shows us that the rapid learner possesses, in the success of his first correct recitation, no guarantee of permanent retention, a fact which may constitute a serious danger for children. The whole method of memorizing, in the case of a typically rapid learner, aims to secure a transitory and temporary retention rather than a permanent one. His recitation from memory bears a closer resemblance to immediate retention in that it employs the after-effect of impressions which have just been received, with a view to reproducing by means of these. Immediate retention by means of after-effects which have not yet died away from consciousness is, however, as we have seen, a highly specialized mental phenomenon which must be

distinguished from lasting retention or genuine reproduction.[1] Immediate retention depends upon other means than mediate retention, the impressions having wholly disappeared from consciousness in the case of the latter, while the former has recourse chiefly to the dying away of the original stimuli.

The retention of the rapid learner bears a close resemblance to that purely immediate retention which is possible only so long as the direct after-effect of the sensory impressions of the learned material still persists. Hence we find, too, that the rapid learner makes use of all conceivable devices in his immediate reproduction of the learned material,—cadence, rhythm and accentuation employed in presentation, auditory after-images of words in their original timbre, more rarely their visual images, and the like.[2] The state of affairs is wholly different in the case of the slow learner. He requires a longer time for learning, employs more repetitions, and not infrequently expresses a desire to allow the learned material to "soak in" for a time. He reproduces with a high degree of assurance, and in a tempo which is usually slower than that in which he learned; and, even after several minutes, he is still able to reproduce with the same assurance as during his first recitation.

Both of these types of learning are characterized by numerous other features. The individual who learns rapidly and forgets rapidly is, as a rule, unable to supply a missing syllable by reflection; every attempt to do so is attended by a consciousness of the utter futility of the effort. The slow learner frequently succeeds in finding a missing syllable after

[1] See pp. 41ff. of this volume.

[2] Memory experiments have failed to take immediate retention sufficiently into account. It appears, however, that certain psychologists make allowance for its influence in delaying recitation for a time, up to two minutes, after learning.

a moment's reflection, and recalls it in definite form. The rapid learner retains the first syllable of the series with special accuracy; and if it escapes him in the reproduction, the whole series is usually lost. The slow learner is sometimes able to begin his reproduction at any point in the series, and to reconstruct it in a forward or a backward direction. The mode of learning also is different in the two cases. The slow learner spends a great deal of time upon the mere reading of the series; the rapid learner soon begins his attempt to "recall," merely glancing at the syllables in order to test and control his continuous attempts to reproduce, which run on in advance of the syllables read. The attention of the rapid learner is more readily distracted by trivial incidents of all sorts, to which the slow learner pays not the slightest heed. The emotional tone during the learning is different in the two types. The rapid learner is enthusiastic; he learns with a feeling of excitation and of pleasure, and with a vivid desire to reach his goal rapidly. The slow learner is more indifferent, especially at the beginning of the new experiment where he may even feel an unpleasurable tenseness and anxiety lest he do not reach his goal without a too great expenditure of time. The profit which the slow learner derives from practice is, in most cases, relatively much greater than that which accrues to the rapid learner. In a long-continued series of experiments, *Z.*, mentioned above, required 56 repetitions at the outset, but after several months' practice he required only 19 repetitions; while *P.*, in the same series of experiments, reduced his repetitions from 18 to 8.

It must not be supposed, however, that on account of his rapid forgetting the rapid learner is at a disadvantage in relearning or refreshing his former impressions. Corresponding to his rapidity in the learning of new material, is his rapidity in the re-learning of old material. He is able to make

abundant use of the slightest traces which may have survived from the original learning. *P.* frequently made a greater saving of repetitions in re-learning than *Z.* On the other hand, the rapid learner is always found to be at a disadvantage when called upon to reproduce freely without re-learning. Quite as surprising is the characteristic difference of the two types in the reproduction of sensory material which has just previously been read or heard. The rapid learner possesses a considerably more efficient "immediate retention." In our experiments, the largest number of nonsense-syllables which could be reproduced correctly after once hearing them was eight for *P.*, but only three for *Z.* A similar difference is found in children; a pupil of the rapid type succeeded in reproducing six, while a slow learner of about the same age recalled only three syllables in immediate reproduction. It appears, however, that two sub-types are found among rapid learners. There are individual cases of rapid learners who are able to retain well. These individuals clearly possess the most efficient sort of memory. It is the rapidly learning and rapidly forgetting individual who depends most upon immediate retention, and who at the same time seeks to obtain a fleeting and transitory memorial effect. In the rapid learner who also retains well, we find a combination of rapid acquisition with a will to imprint permanently.

What constitutes the basis of these differences of memory type or learning type? At present, we can say only that the chief cause of the difference is to be found in fundamental differences of attention. It is chiefly the rapidity of accommodation or central adaptation to the activity in question for the moment, or to the material in hand, which gives rise to the different effect of learning. The rapid learner possesses a capacity to accommodate his attention immediately to the peculiar demands of the activity of the moment. Within a

very brief time he has already reached his maximum degree of concentraion; he does not find it necessary to struggle with the typical distress of "beginning," with reluctance, with disinclination, with wandering wits, and the like. The result of this is that the initial repetitions immediately attain their complete or almost complete effect for memory; and no part of his work fails to produce a memorial result. The individual who adapts himself slowly must, on the contrary, expend several repetitions at the outset in attaining a complete adaptation to the activity and to the material before him, and in overcoming distracting ideas and feelings of unpleasantness. He reaches his maximal concentration only by a gradual process; and his first few repetitions are of little value, in so far as their effect upon retention is concerned.

The obverse of this difference in accommodation of attention is to be seen, however, in the fact that the rapid adapter soon loses his accommodation again. But no serious damage results from this lapse because he very soon regains possession of his accommodation. This is especially evident in the effect of pauses. Brief pauses, introduced into the act of learning, are usually welcomed by both types of learner; but they are long avoided by the slow learner because he fears that he may lose his adaptation to the activity of memorizing. The advantage derived from relaxing during a pause seems to him to be illusory if he must recoup the loss by a subsequent re-adaptation of attention. Is it of advantage to be able to accommodate the attention rapidly? We must answer that both this capacity and its opposite have their advantages and their disadvantages. The individual who adapts rapidly is able to pass abruptly from one activity to another, a feat which is more difficult for the slow adapter. On the other hand, the latter is able to proceed with undimin-

ished energy and concentration after brief pauses because his adaptation persisted throughout the pauses.

The adaptation of attention to the activity and to the content which engage us for the moment brings with it a phenomenon which is significant for all mental work; we may refer to it as our "adjustment" (*Einstellung*) to the activity of the moment. By this we understand that every long-continued activity arouses in us a tendency to persist in the same activity. This, of course, makes it more difficult for us to pass over to other activities. Our behavior may be compared with that of an optical instrument which has been adjusted for a particular distance, and therefore images all nearer or farther objects indistinctly, or not at all; or with a railway train which is forced along a particular track by means of a switching device,—an analogy which was first employed by Exner. Attention and will constitute the switching mechanism of mind; but it is especially attention which puts forth its greatest energy in the direction in which it has once started. What does not lie in that direction may enter the field of consciousness, it is true, but it can never reach the focus of consciousness. The more our attention becomes adjusted to an activity, the stronger is the fixedness of tendency, the more difficult is it to pass from an initial activity to any other, the more does concentration increase, the more successfully does the mental operation progress, and the greater is the after-effect upon memory. This is the chief cause of the difference between rapid and slow learners; but there are secondary causes also. The purpose or intention with which we enter upon the work of learning has a prime significance. The more we intend to obtain not merely a transient but a lasting effect, the more is this desired effect produced. There is also a significance attaching to the sort of means which we employ. The more extensively we make

use of secondary means, such as special auditory and visual remembrances derived from non-essential circumstances which attend the learning, the more transient is the retention. The learner's habituation to slow or to rapid work also plays a part; we should therefore accustom ourselves to working rapidly. And it is possible that there are also fundamental individual differences in the rapidity with which memory dispositions take shape. Finally, the ideational type of the learner is also a significant factor.

These typical differences in rapidity of learning reveal the existence of two readily distinguishable types of mental work in general; and these types appear to have their foundation in certain elementary properties of attention, which are not uniformly distributed throughout the human family. The attention which adapts itself slowly to its work is, at the same time, an attention which clings tenaciously to its work, shifting only with difficulty, and offering the most secure guarantee for the permanence and fidelity of the content which it acquires. With this is intimately related yet another fundamental difference in the attention of different individuals, which we may call a difference in the concentration and distribution of attention. Every-day experience teaches us that certain of our fellow-men are more capable of attending to several things at once; the attention of these individuals has a greater power of distribution. Other individuals resolutely avoid attending to many things at any one time, preferring to concentrate more intensively upon the few things to which they do attend. To this type of attention we ascribe a high power of concentration. Concentration and distribution are therefore, to a certain extent, mutually exclusive because wide distribution of attention is accompanied by but slight intensity of concentration upon particular details; but we ordinarily find that it is also associated with a breadth of

interest, a high degree of susceptibility and, since it usually goes hand-in-hand with abrupt adaptation, with rapid acquisition. From this outline it is easy to complete the picture of a highly concentrated and narrowly distributed attention.

These two fundamental characteristics of attention equip their possessors for different callings, and constitute the basis of different talents and endowments. The broad, inclusive, rapidly adapting, and as rapidly shifting attention qualifies one for journalism, diplomacy, the medical and the teaching professions; it is fundamental to the artistic endowment, to the capacity of improvising, to readiness in repartee. Concentrated attention is a necessary condition of specifically scientific endowment.

The opinion of certain psychologists that these two characteristics necessarily exclude each other is erroneous. Attention is capable of being developed in any direction; practice increases both its intensity of concentration and its extent or compass. Yet it must be granted that we find it easier to develop the attention in but a single one of these two directions. One must not overlook the fact, however, that even a distributed attention can apply itself with a high degree of concentration to particular details. An attention which is at once distributed and intensive seems to represent the highest degree of concentration, if by concentration we mean the energy with which attention can be turned upon its object. The opposite of concentration in this sense does not consist in distribution but in distractibility. Moreover, concentration may mean limitation; and only when understood in this sense is it opposed to distribution.

These fundamental properties of attention exercise their influence upon learning more in the mastering of bulky amounts of material than in short series of syllables. This may explain how it comes about that in cases of large amounts

of material the superiority of the rapid learner to the slow learner frequently decreases and may wholly disappear. When the task is long, the slow adapter gradually gains a greater advantage over the rapid adapter because the former usually possesses the less extensive but the more intensive concentration. Another illustration will show what rôle the adaptation of attention plays in the life of the pupil. Burgerstein asked a whole class of pupils to memorize stanzas of poetry; and the task was continued for a full hour, the time required by each pupil for the memorization of each stanza being noted. It was found that during the first half-hour the duller pupils memorized much more slowly than the brighter pupils; but this difference gradually decreased to the vanishing point as the work progressed; and all of the pupils learned the later stanzas in approximately the same time. This result may perhaps be explained by assuming that a slow adaptation goes hand-in-hand, in many cases at least, with a lesser degree of mental endowment. Indeed, Binet has attempted to show that rapidity and degree of adaptation of attention may be employed as criteria of intelligence in school-children. But on repeating Binet's experiments, Winteler found this result to be only partially confirmed.[1]

A group of variations which have been called *Memory-types* are in many ways closely related with these learning types. This unfortunate term[2] refers to certain thoroughgoing diversities in the content of the ideas of different individuals; and it would therefore be more appropriate to call them ideational types. I shall attempt to make clear the

[1] See Bibliography at the end of the volume.

[2] Others have referred to them as types of intuition, sensory types and even as speech types. I believe that the expression "ideational-types" is the only appropriate term to apply to them, because they relate primarily to ideation in the narrower sense.

nature of these ideational-types, and to discuss the question of their relation to types of learning. Fundamental differences in the content of sense-impressions from which the ideas of individuals are built up were first brought to the notice of psychologists by the psycho-pathological observations of Charcot, and more particularly by the investigations of his assistant, Ballet.[1] According to Charcot's view, reproduced ideas are not always derived from the same sense-department. In the act of thinking, certain individuals employ chiefly the ideas of concrete objects which they have perceived, while others employ words chiefly,—the thinking of the latter group of individuals being referred to as "internal speech." It is found, too, that different individuals recall verbal images to consciousness in different forms; one hears the auditory images of words, while another has a mental revival of the muscular sensation arising from the adjustment of his vocal apparatus, or he may actually innervate the vocal muscles in his internal speech; and yet another sees before him the visual images of written or printed words. Accordingly we may distinguish an auditory, a motor and a visual type of ideation. Of course, combinations of all these varieties of ideation may occur as "mixed types," or, less accurately expressed, as "indefinite types" More recent investigation has made many modifications in the earlier conception of ideational types, to which we shall turn in the next section.

Now we are led to suppose that these diverse characteristics of ideation give rise to different sorts of learning, and that the latter are related to the learning-types which we have mentioned.

Even the apprehension of sensory-impressions, which constitutes the first step in the act of learning, must be different

[1] J. M. Charcot, *Lêçons sur les maladies du systeme nerveux.* Paris, 1873. G. Ballet, *Le langage intérieur*, Paris, 1888.

in individuals whose modes of ideation are different. The visualizer imprints upon his consciousness a picture of the printed or written word and of the spatial arrangement of its parts. He notes their position by means of his memory for location; he remembers the lines as they appeared upon the printed page, and he knows approximately how the more important or interesting parts, at least, are distributed upon the pages. Before his "mind's eye" there arises a picture of a poem divided into stanzas and lines, etc. The individual who belongs to the auditory or to the motor type immediately transforms the visual pictures, obtained from reading, into heard or spoken words; and these auditory or motor images he substitutes for the visual images of the printed or written words. The process of learning or imprinting is even more radically different in the various ideational types. In the auditory and motor types, the process of imprinting consists in the formation of series of successive auditory or vocal images of spoken words, or series of successive innervations of the vocal muscles, which, in turn, are accompanied by sensations or images of movements; or he makes a mental note of the "melody" of what is spoken to him, and he remembers the sounds and the rhythmic sequence of the words and syllables which he memorizes. And in this melody the various sounds then assume their proper auditory and rhythmic positions. Now, in the act of reproduction, the auditory or motor individual is unable to present the whole series simultaneously to his consciousness; his only alternative is to allow the successively learned items to run their course again in successive order, in the form of either concrete or verbal images. The individual who remembers visually proceeds in a wholly different fashion. The syllables or letters which are to be remembered, he arranges side by side in the form of visual images; and the result of this internal vision, namely

his visually ideated series of letters, he can see before him either simultaneously or in successive sections. In the act of reciting he simply directs his mental regard upon the series; his retention is simultaneous rather than successive. It is exceedingly difficult for an individual of the auditory type to recite a memorized series backward, because his associations between the terms of the series were formed almost wholly in a purely successive order; and successive associations always operate more strongly in the direction in which they were formed than in the reverse direction. On the other hand, the strongly visual individual is distinguished by an ability to reproduce his associated groups of letters, etc., backward almost as easily as forward. He experiences no difficulty in running his internal glance in a backward direction over what lies in the field of his mental vision.

Unfortunately we possess as yet no investigations which have made a special study of the relative fidelity of retention by the various ideational types. But from incidental results obtained in other investigations of memory we can see clearly that visual memory is slower but more sure and reliable.[1] The individual who learns visually also experiences, as a rule, a more vivid feeling of certainty. In experiments with nonsense syllables, we very frequently observed the manner in which the various observers recall forgotten syllables by a process of reflection. Most observers report that the forgotten vowel or diphthong first floats into view; and in cases where forgotten consonants also "occur" to the learner, they too, usually make their appearance in visual form. But if

[1] According to Pohlmann, this is especially true for nonsense syllables; and according to Finzi, it is true also for concrete objects. The statement seems to me to be self-evident. Compare the investigations of immediate retention and of observant noting which we have already discussed.

this does not happen, the feeling of uncertainty still persists. This is in accord with Finzi's observation[1] that in experiments on apprehending and noting, visual images are less subject to falsification than auditory images. It is probable then, that visual images are retained more faithfully than any other sort of content. My own experiments show that the retention of numbers, and consequently mental calculation, is accomplished more slowly but much more correctly when the digits are ideated also as visual images than when they are reproduced only in the form of auditory-motor verbal images.

From this we must suppose that exceedingly slow learning is to be explained from two fundamental differences of disposition and endowment,—from the slow adaptation of the individual's attention to the activity upon which he is engaged, and from the predominance of visual ideation, under which we have still to consider all of the secondary factors which have been mentioned.

In how far is it possible to eliminate these differences in endowment which constitute the basis of memory function? This is an important question for pedagogy but we have as yet no decisive or final experiments dealing with the topic. Yet in all of our investigations we find that the elementary attributes of attention are capable of almost unlimited improvement in every direction, if only they are submitted to an adequate training. Rapidity of adaptation, and the intensity and compass of concentration may be developed to a high degree; and any particular sort of ideating can be acquired by training, if there is not a complete dearth of ideational elements from the corresponding sense-department in the individual's consciousness at the outset. I myself am dominantly non-visual in my ideation of verbal material. All of my learning at school was auditory-motor; I have never

[1] J. Finzi, *Ibid.*, p. 377.

been able to remember places in books, and the orthographic images of foreign words have given me great difficulty in all cases where the spelling does not conform with the pronunciation. In psychological experimentation I have cultivated visual ideation to such a degree that I am now able to solve arithmetical problems by means of auditory or of visual images as I prefer; I can learn a group of letters, numbers or syllables, by means of auditory, visual or motor imagery. I always find that visual noting and computing is essentially slower but more sure; I seldom make a mistake in visual computing.

It was the French psychologists who first called attention to the fact that the elimination of differences in memory-types by devoting a special training to ill-developed types of ideating always brings with it a certain loss in one's connate type. Thus, the individual of the auditory type suffers a certain loss of auditory imagery when he trains his visual ideation. This is just what our every-day experience with the one-sided development of capacities would lead us to expect. But the loss is only a temporary one; the person who submits to training gradually acquires a capacity to work with all of the means of ideation which he has practised.

These considerations indicate that each ideational type possesses certain advantages and certain disadvantages. When the visualizer learns by means of observation he is condemned to work relatively slowly; the auditory-motor individual always seems to possess a less reliable but a more rapid memory. And although the visual memory is less likely to falsify its single ideas, still the visualizer is more prone to blunder when he learns whole groups of ideas. In reproducing large groups of impressions he is more subject to errors of position, although his retention of single impressions,—letters, syllables and words,—is better; on the other hand, the individual

who belongs to the auditory type is more likely to confuse words of similar sound. The auditory-motor individual profits from his successive procedure in forming associations; he does not so readily confuse the order of the parts of his material as the visualizer does. From this it must be inferred that a perfect memory must have its foundation in an all-round development of ideation. The teacher should note the diversities of memory which are due to a relative lack of one or other sort of ideational content; and he should seek to eliminate these defects by appropriate training.

We must not fail to bear in mind, however, that most of the experiments which we have described were made with adults, twenty to forty years of age, and in psychological laboratories. Since the mind of the child, especially in so far as memory is concerned, is much more plastic, one would expect that if the adult can acquire such a high degree of cultivation of memory and of the elementary attributes of attention, the schools should be able to attain much greater results. And this expectation is fulfilled, according to the findings of Radossawljewitsch, who, in an investigation of the memory of eleven school-children from seven to thirteen years of age, found that the ideational types of children are modified by long-continued learning. All of his observers gradually approached more and more closely to the auditory (probably the auditory-motor) type of memory, because in his experiments the learning was done solely by a method of reading and *sotto voce* pronunciation. Radossawljewitsch observed this phenomenon in himself also. In my own experiments with nonsense syllables, I have repeatedly found that my ideational type always takes the following form after a long period of learning: I retain chiefly in auditory-motor fashion, and reinforcement by means of visual images is a wholly secondary matter. Anything that has been learned

verbally, however, is usually retained solely in auditory-motor terms, with auditory imagery dominating.[1] Teaching should therefore be supplemented by formal training, which unfortunately is unknown in the modern curriculum. Gifted educators of all ages have demanded purely formal mental training. Pestalozzi developed the concentration of his younger pupils by having them perform simple manual exercises during their learning. Froebel's whole system of kindergarten plays is permeated with the idea of giving the child formal exercises in order to develop his capacities. The material employed in these exercises is a matter of relative indifference, in so far as subsequent education is concerned; its acquisition is only a secondary purpose of the training. Laboratory investigations of the development of the mental functions of adults show us what an enormous loss is entailed in modern education as a result of its prevailing emphasis upon content as the essential aim in teaching. In view of the fact that the students in our universities must be taught to see correctly and to hear correctly, that they scarcely know what their mechanical memory is capable of accomplishing, that accuracy and fidelity of description are not developed until they come to our laboratories for experiments, that elementary differences of endowment are levelled down so little during the first twenty years of their lives,—in view of all of these facts, it appears that our modern system of education fails to fulfil the demands both of science and of practical life. This state of affairs has contributed to the success of certain advocates of mnemonics, whose methods are guilty of shocking psychological blunders but yield abundant renown to their authors. The memory of modern man is wholly neglected in so far as its formal aspect is con-

[1] P. Radossawljewitsch, *Das Behalten und Vergessen bei Kindern und Erwachsenen*. Leipzig, 1907, 169.

cerned; even an improper memory training is better than none at all.

Our generation keenly feels this fundamental need of a formal training of our mental capacities by means of appropriate methods. This seems to be the only reason which can account for the luxuriant crop of modern literature in which certain individuals undertake to show their fellow-men "the right way to do mental work," to teach them "the art of never forgetting" by a system of mnemonics, and to "make men strong" by courses of instruction. Our next discussion will deal with the psychological development of methods of teaching which may supply this need, in one direction at least.

2. *More Detailed Description of Ideational Types and Memory Types, and their Fundamental Characteristics*

In our preceding discussions, typical differences in the ways in which different people "think,"—or, more correctly, ideate,—and retain, have been brought into relation with typical differences in learning. Our knowledge of these ideational types, which have only been hastily sketched in the preceding section, constitutes at once the basis of a psychology of memory and of a pedagogy of learning, in the broadest sense of the latter term. Every sort of memory process runs its course differently in individuals of different mental types; and different methods of learning come into being because one or other of the general conditions of learning leads more readily to the desired goal, and likewise because there are individual ways of learning. Hence before we proceed to develop a doctrine of the technique and economy of learning, it is appropriate to undertake a more exact analysis of those interesting differences of ideating and remembering which, strangely enough, were not appreciated until the modern era of psychology and psychiatry.

The investigations of these individual differences, like the investigation of so many other problems which have been raised by modern psychology, have by no means reached their final stage as yet; still we already possess a wealth of interesting observations and experimental data which give us some insight into the complex mechanism which the individual employs in his memory work.

I shall attempt briefly to describe the ideational types under the following headings: *a.* An analysis of rare cases of extremely one-sided memorial endowment such as we occasionally find in noted artists, rapid calculators, chess-players, and others of highly developed talents. *b.* A discussion of certain pathological conditions of mental life. *c.* A description of the differences between the memory of the child and of the adult. *d.* A discussion of methods of determining memory types.

All persons appear to think[1] in either of two wholly different forms. These forms do not, however, alternate with each other in a fortuitous and purposeless fashion; but each comes into operation on certain definite occasions and for the realization of certain definite ideational purposes. We all think either in concrete images of former perceptions of objects or processes, or we think in words which we speak to ourselves. In the former case, consciousness is dominated by residua, after-effects, or traces of former sense-perceptions, and more or less original and novel combinations of these. This form of ideating is therefore called concrete or objective ideating. The ideas which dominate us in this case are subdivided, by psychology, into ideas of imagination and ideas of memory. They are ideas of memory when they appear to us to be subjective copies of objects or processes which we have for-

[1] The word "think" will, in what follows, be used as a general term to include every sort of ideational activity.

merly experienced. In ideas of imagination this trans-subjective reference to former impressions is lacking; and in the adult, ideas of imagination have not infrequently been found to have come into being from numerous combinations, cleavages, variations and fusions of former ideas of memory; so that they seem to be exceedingly complex structures, in which now one, now another, component idea predominates in consciousness, in consequence of the cohesion and constellation of ideas.[1]

Verbal thinking or thinking in words is wholly different from this sort of ideation; and it also takes place under circumstances which are different from those under which concrete or objective ideation occurs. Indeed, the two sorts of intellectual function are, in a certain sense, mutually exclusive and antagonistic to each other, as we shall see. We think chiefly in concrete or objective terms when we give free rein to our imagination, when we have no definite problem before us or when the problem is of a purely concrete sort, when we go back over our remembrances without attempting to recall any particular person or event. On the other hand, we think in words in the form of an unspoken, internal speech when we deliberately follow a definite train of thought; when we reflect upon scientific problems, and especially when our real thinking comes into operation in the form of judgments; when we converse or argue with anyone; when we, in any way, put ourselves in the position of a speaker; and particularly when we reproduce, in words, a verbal context which we have learned. But it seems to be chiefly the contrast between concrete imagination and abstract thought which constitutes the contrast between the two forms of

[1] A more detailed discussion of the distinction between ideas of memory and of imagination may be found in Meumann's *Intelligenz und Wille*, Leipzig, 1908.

ideation. In many persons, perhaps in all, the two forms of thinking are directly opposed to each other. The more concretely my imagination works, the more do my verbal images retreat to the background of consciousness; the more intent I am upon following an abstract train of thought, the more do I think in terms of internal speech. The two sorts of ideation are also opposed in habituation and in inclination. For days and weeks at a time my internal speech predominates; and for equally long periods, concrete imaginations or persistent remembrances crowd my auditory-motor imagery into the background. It is no wonder, then, that fundamental differences of individual endowment should have their foundation in the opposition between these two sorts of ideating. Artists and musicians seldom show an inclination toward scientific thinking; and leaders in science are usually indifferent artists. From the introspective analysis of numerous individuals of both groups, one can see clearly that concrete ideation is dominant in the artist, while verbal thinking is dominant in the scientist.

The sort of activity which we have designated briefly as internal speech or verbal thinking is, in all probability, everywhere a thinking process in which verbal meanings are faint and indistinct, and in which, under certain circumstances, they may even be absent from consciousness. The internally spoken word is the mental representative of the meaning of the word; it is a substitute for a more accurate envisagement of verbal meaning. And we shall see that the manner in which words are imaged and employed as symbolic representatives of meanings may be wholly different in different individuals.

In both sorts of ideation, in concrete-objective and in verbal thinking, wide individual variations occur. These are chiefly and primarily due to the fact that the concrete sensory com-

ponents of which words and ideas are made up differ radically from individual to individual. In the visualizer the parts of concrete or verbal images consist wholly or chiefly of memorial residues of visual experiences; in the auditory individual, on the other hand, the auditory images are dominant; and in the motor individual, vestiges of movement sensations or actual, if weak, repetitions of former movements constitute the essential content of consciousness. It must be borne in mind, however, that an individual who possesses chiefly concrete visual imagery does not, for that reason, proceed exclusively in a visual fashion in his verbal thinking, that is, he does not think solely in terms of visual images of written or printed words. The differences between the ideational types are, remarkably enough, of a much more complex sort; for instance, the concrete visual type of ideation may co-exist in any individual with verbal ideation of another sort,—with vocal-motor or with verbal auditory imagery. The asymmetrical development of individual endowment in ideation and in retention, which we are accustomed to call ideational type, must therefore be discussed both from the point of view of concrete ideating and of verbal thinking.

Individual differences do not present so many remarkable features in the former as they do in the latter; and a greater pedagogical significance also attaches to individual variations of verbal thinking. We shall therefore devote but a very brief discussion to the typical differences of concrete-objective ideation.

First of all, it must be noted that the manner in which an individual ideates his sensory impressions and his objects of perception, in concrete form, is in every instance determined by two factors: the character of the impression, and the ideational type of the individual. In any given case, therefore, we must always take into account the sort of impressions

to which the memory-image owes its origin. The impressions which are to be retained in memory may have originated from several or from only one sense-department; and the ideational type may be a "pure" one, that is, it may be exclusively auditory, motor or visual. Let us assume that, in a particular instance, an individual is called upon to remember an impression received through but a single sense-department, —a color, let us say. If he belongs to the pure visual type, his ideational type corresponds to the sort of sensory material with which he is to deal; and he will ideate it by the corresponding or "adequate" means. But when the individual who is purely auditory is called upon to ideate colors, he finds himself unable to do so by the means which corresponds to the stimulus in question because he possesses no visual imagery; he must therefore have recourse to a non-adequate means of ideation. He may employ a symbol or "surrogate" for the color image; and he may have recourse either to verbal ideation,—the verbal image of the name of the color being substituted for the concrete image of the color itself,— or to verbal ideation combined with an act of judgment,—he may remember that he has seen something which is called red or he may call to mind the circumstances under which the color was seen and these will then enable him to recall the color.

Representatives of all of the pure types proceed in this latter fashion when called upon to ideate sensory material of a modality to which their ideational type does not conform. Possessing no concrete imagery of this sort of sensory material, they substitute an appropriate name or the consciousness that they formerly experienced a similar impression.

In the great majority of our every-day experiences we are not called upon to learn and remember material from but a single sense-department. Most objects present stimuli which appeal to several or to all of our senses. When engaged in

conversation with any one, I have a visual perception of his body and his gestures, I hear the sound of his voice, I may touch his clothing; and thus I perceive him through the medium of three of my senses. In all such cases, the representative of a pure type of imagery may have recourse to those images which correspond to his own type; the purely auditory individual would remember only the audible speech,—clang-tint, inflection, tempo, and rhythm; the pure visualizer, only the visual picture of the speaker and his gestures. And those classes of impressions which correspond to the individual's type of imagery must then symbolize all of the others; and they must constitute for each individual his sole but one-sided remembrance of the incident. This is true in the case of Dodge, for instance, who is wholly lacking in auditory imagery. Dodge's visual memory of the appearance and the movements of his fellow-men serves as a substitute for a remembrance of their voices.

Investigation has shown, however, that the great majority of people belong not to pure but to mixed or balanced ideational types. In these cases, we have a compromise between ideational type and sense-modality. When they endeavor to remember impressions of a single sense-department which is not identical with their ideational type,—for example, when an auditory individual whose visual imagery is weak is called upon to remember colors,—we observe a phenomenon which is wholly different from that which we observed in the case of the pure types. The "mixed type" is made up of individuals in whom images of some particular sense-department or sense-departments predominate; they work most readily with this sort of material, and these images are found to be more distinct and complete than any of their other sorts of imagery. But they can also make use of the less distinct and less readily reproducible sorts of imagery

The representative of the mixed type relies chiefly upon those images which predominate in his ideation; and he makes use of the other sorts only in secondary fashion. Thus, when the stimuli themselves are of mixed sorts, he selects the sensory elements which correspond with the dominating elements in his own imagery. The representative of the mixed type, who, for instance, possesses distinct visual imagery but indistinct auditory imagery, remembers his fellow-men chiefly in terms of visual images; the auditory image of the voice ordinarily coöperates to some extent, but only in an indefinite and uncertain manner. The procedure is different, however, when the stimulus belongs to a sense-department which is not dominant in the individual's ideation, and also when he is called upon to remember those parts of a composite stimulus which do not dominate in his imagery. For instance, when an individual of the auditory type, who possesses weak visual but strong auditory imagery, remembers colors or forms, his remembrance contains visual elements but they come to consciousness indistinctly and indefinitely. When he has to recall and describe the visual image of another person his ideation adapts itself to this task also; the visual elements of his imagery are now accentuated by his attention, and in consequence they are temporarily raised to predominance but still they remain relatively indefinite and indistinct. Then the attention accentuates these more indefinite elements of his imagery, and drives the more definite material temporarily into the background.

From this we see that in concrete ideation the individual who possesses a mixed or balanced imagery works, as a rule, with those elements which are normally dominant in his ideation. It is just that which constitutes the type. But because the possessor of mixed imagery has vague images from several sense-departments, these come forward as

the dominant elements when they correspond with the stimulus of the moment or with the problem which has been undertaken by the individual. It must be borne in mind, however, that the possessor of mixed imagery adopts different procedures for immediate and for permanent retention.

In immediate retention he is confronted by the definite task of remembering a particular sort of sensory material. Let us take the case of an individual who has read a list of words, or to whom such a list has been dictated, with a view to having them reproduced immediately in vocal form. The mixed type is always able to adapt itself to this task. Even the visual individual operates chiefly with his weak auditory images when he attempts an immediate recall of words which he has heard; at least, I have always found this to be true of my observers whose auditory images were not exceedingly weak. Here, however, we must always assume the presence of an intensive immediate after-effect of the original stimulation which facilitates this adaptation to the task in hand. In recalling auditory words immediately after hearing them, the visualizer may employ auditory images chiefly, but may make a secondary use of the visual imagery into which he has transformed the auditory material; but in recalling a conversation with a friend after a long interval,—that is, in a case of genuine ideation,—he has recourse chiefly to visual images of expressions employed by his friend during the conversation. The individual who belongs to a pure type, on the other hand, endeavors in immediate retention to transform into his own favored imagery the sensory impressions which he receives.

It is essential that we bear in mind that most impressions from the external world come to us through the visual sense; and experiments have shown that most persons belong to the mixed type in so far as their concrete imagery is concerned.

It is not difficult then to understand why visual elements should dominate the concrete imagery of the majority of persons who possess a full complement of sense-organs. Most persons recall their past experience in terms chiefly of residua of former visual impressions. Sensations of pressure, temperature, taste, and smell, and even auditory sensations are relatively secondary throughout. The majority of mankind, then, belong to the visual type in so far as their non-verbal ideation is concerned. This shows us, too, why the type usually fails to be identical in concrete and in verbal thinking. Most people who possess a full complement of sense-organs are found to be auditory-motor in their verbal ideation; in the majority of individuals, then, we find a combination of visual concrete ideation and of auditory-motor verbal ideation. Verbal ideation employs both auditory and auditory-motor imagery; hence the representative of the mixed type finds himself well equipped for verbal ideation. Within these various types of ideation and retention we find that individual endowment may vary between wide limits. Thus it is found, on the one hand, that the ratio of the dominant to the secondary sorts of imagery in a consciousness of the mixed type may vary between an upper limit which represents an almost complete absence of secondary sorts of imagery and a lower limit which represents little more than an equal distribution of dominant and secondary sorts of imagery; and on the other hand, we find equally wide variations in the permanence and fidelity with which imagery is retained in memory. Numerous individual variations may therefore be observed within the chief ideational types; and we find individual variations and sub-classes of each of the sub-types, as has recently been shown by G. E. Müller.[1] The extreme case of visual endow-

[1] G. E. Müller, *Gedächtnistätigkeit und Vorstellungsverlauf*, Leipzig, 1911.

ment is frequently observed in individuals who have devoted themselves to the plastic and the graphic arts. Dr. Wigan tells of a painter who habitually dismissed his model after half an hour's sitting, and then painted, from memory, as though the model were still before his eyes. He recalled to consciousness a picture of the model sitting upon the chair, varied the posture, the expression and the coloring at will, and had the visual image as clearly before him as though the model were present. Similar incidents are reported of Peter von Laar and Henri Regnault. Anselm Feurbach relates in his "Testament" that before painting certain of his pictures he planned and executed them mentally "to the last brush stroke."[1] The visual memory may, again, be chiefly and one-sidedly a form memory or a color memory; nor does it always exist in combination with a highly developed visual perception. In contrast with those individuals who possess a superior endowment of visual imagery, we find others in our psychological laboratories who have had a thorough and well-rounded mental training and yet are scarcely able to recall a single color or visual form accurately.

We can do no more than offer conjectures as to the origin of these cases of asymmetrical individual endowment, and of gradual variability in the dominance of a particular sort of imagery. Binet[2] believes that the development of "special memories" is due essentially to the prevailing direction of the individual's interests and training; but this does not accord with the familiar experience that one's interests are

[1] Interesting statements by artists concerning these phenomena are compiled in H. Popp's *Maleraesthetik*, Strassburg, 1902, 320ff. See also Ballet, *Die innerliche Sprache* (trans.), 46ff.

[2] A. Binet, *Psychologie des grands calculateurs*, Paris, 1894. This work will frequently be referred to, in what follows, by a simple mention of the author's name.

frequently found to lie in a field for which one has no special talent, nor with the fact that professional psychologists have frequently striven in vain to overcome a one-sidedness in their ideational type. Connate endowment is an essential factor here; but how are we to conceive of connate endowment? Of course, it is easy to say that in the case of the visually endowed individual, certain regions, probably in the occipital lobe, come into question; and as a matter of fact Moebius has shown that mathematical endowment is always attended by a marked development of the temporal region, from which he is led to locate the mathematical center in the inferior convolutions of the anterior region of the frontal lobes. But a mere translation of psychological facts into physiological and anatomical terms contributes nothing to the psychological explanation of the asymmetries of memory.

It is more important that we should know whether ideational types are due to congenital bent and disposition (*Anlage*), or whether they are acquired by habituation and training. This question can be answered with some degree of certainty from the facts in our possession. It is probable that a certain degree of congenital mental defect constitutes the basis of every pure type. For this reason, I always regard purity of type as a defect in ideation. The predominance of one, or of several sorts of imagery in the mixed type, however, frequently appears to depend, in part, upon the combined influence of endowment and education; in part, upon the sheer influences of training and habituation. Otherwise we could not explain how, in the training of memory by means of material where a particular sort of imagery preponderates, the ideational type adapts itself in so short a time (often within a few weeks) to this sort of learning. It is undoubtedly possible also that there may be such a thing as an ideational

disposition which is equally well-adapted for all sorts of sensory elements. This general, all-round endowment must suffer modification in consequence of one-sided practice with particular sorts of sensory material; and a habituation type would then come into existence.

There are in general four possibilities as to the mode of origin of the various types of endowment: *1.* They may be due to congenital bent or disposition, which would then be conceived to be the sole determining factor,—the dispositions themselves being conceived to be qualitatively fixed and unalterable. Education and training would not transform them, but only develop what is latent and pre-determined in the disposition. In the case of the ideational type we must then conceive the disposition to be a peculiar individual susceptibility to particular sorts of sensory impressions,—an individual facility for acquisition and an individual aptitude for preservation,—corresponding to the memory disposition. *2.* The types may, indeed, appear to be predisposed by one's congenital bent; the bent, however, is capable of being transformed, but education and training are less effective than the disposition itself. *3.* The ideational type may be due to disposition and education, it is true, but the forces of education have a greater influence than the disposition itself. *4.* The disposition may be of no significance; and education, in the broadest sense of the term, is the sole determining factor.

I regard the second possibility as the most probable, because in ideational types we frequently see the influence of the disposition asserting itself with extraordinary potency; and yet we find a certain influence exerted by educative forces. The significance of the disposition is indicated: *a.* By the evident influence of heredity upon ideational type. Not infrequently do we find that a particular type of ideation recurs in

several successive generations of the same family, a fact which can be explained only from heredity. Dodge reports that his type is a family inheritance. Lay found three pairs of brothers who belonged to the auditory type; the Viennese philologist Nussbaumer and his brother possessed "colored hearing" (Pfeiffer). The predominance of particular sense-memories in families of artists and musicians is well-known. Perhaps the best illustration of this is furnished by the family of Johann Sebastian Bach, in which musical memory was present in conspicuous degree through several generations. *b*. The typical differences between the two sexes likewise point to a congenital disposition. We have already mentioned that women are usually more visual than men. Kerchensteiner found that the color-sense of girls is better than that of boys, and that the former are more talented in decoration while the latter excel in the arts which have to do chiefly with spatial relations.

In addition to this we find, as has already been stated, that a certain variability of type occurs. We shall refer to this later when we deal with the question of the possibility of training the types. More striking, however, than the variation of type is their relative stability. Pfeiffer on testing the ideational types of children of the same school-classes for three successive years found a very marked permanence and constancy of type. Their variations from year to year are so slight that their fixity appears to be the more important phenomenon. From the tenth to the eleventh years, the "visuals" were found by Pfeiffer to decrease by 8.7 per cent.; the "auditories" remained approximately constant; the "motors" increased by 8.7 per cent. In the following year the "visuals," among the same children, increased by 2.4 per cent.; the "auditories" decreased by 1.5 per cent.; and the "motors" decreased by .9 per cent.

Before we can understand the nature of these differences of ideation we must answer another question: Are the differences traceable more to an original primary strength of sense-memory, or to a congenital primary direction of attention toward certain sensory contents?

This problem cannot, of course, be solved by merely pointing out the "circular" course or reciprocal relationship of these processes,—by showing that intensive sensory impression arouses greater interest and this, in turn, reacts upon sense-impressions and intensifies them. The whole of psychology is permeated by this view, namely, that sense-impression, sense-memory and direction of attention are capable of reinforcing and intensifying one another. But this does not solve the problem as to which is primary. I am of the opinion that a typical direction of the attention upon particular classes of sensory impressions must be favorable to the perception and retention of these impressions;[1] and I also believe that the supra-normal domination of any modality of sense-memory may also result in a favoring of that modality by attention, and the more so the more one-sided the sense-memory is. But in our mental endowment, dominant attention and dominant sense-memory may be predisposed independently of each other. I believe, moreover, that individual differences in the sensory content of imagery are due primarily to the retention and reproduction of this content itself, and that they are reinforced in only a secondary fashion by an individual direction of attention. Strictly speaking, therefore, ideational types must be called association types, because: *a.* Our dominant interest in certain sensory material does not always coincide with our dominant sense-memory. Indeed, it not infrequently happens that one is deeply interested in a sense-department for which one's memory is not especially

[1] *Cf.* our discussion of Observational Noting, pp. 63ff.

well developed. *b*. The investigation of observational noting and more particularly the investigation of testimony show that the prevailing direction of attention is determined not by sensory contents but by wholly different and more general causes, namely, by our practical interests of life, and by our theoretical interest in knowing and understanding the external world. It is possible, then, that the dominant sense-memory and the dominant direction of attention may be discrete and unrelated in our mental constitution. The two may go hand-in-hand, but they do not necessarily go hand-in-hand. If they do follow parallel paths they will reinforce each other; and even if their paths are not parallel this reciprocal or "circular" reinforcement may still take place. But it may also happen that the prevailing direction of attention is of advantage to the sense-memory toward which one is least strongly disposed. *c*. No matter to what ideational type an individual may belong his attention is directed to all sorts of sense-impressions in his acts of perception. If notwithstanding this fact the extreme representative of any ideational type is unable to reproduce certain sorts of sensory-impressions, it is clear that attention is only a secondary factor in determining the ideational type. Even when attention is attracted as intensively as possible to auditory impressions, individuals like Dodge are still unable to evoke auditory imagery. Such designations as "sensory types," "intuition types" are therefore misleading. These typical differences are not due to differences in the functioning of the senses.

It should also be pointed out here that all of the traditional terms which have been employed to designate these ideational types are far from being accurate. Each type should be designated not only in terms of the sort of imagery which it possesses, but also in terms of those sorts of imagery which it lacks This plan would provide us with much more definite

names. We describe color-blinds in terms of the colors which they do not see; for instance, we speak of the red-green blind, and in so doing we designate him positively as being capable of seeing yellow and blue. Similarly, a representative of the pure auditory ideational type is a non-visual-motor. A more accurate characterization is especially needed in the case of the mixed or balanced types. Here it is solely a question of determining and designating unequivocally whether a sort of sensory element is lacking, or whether it is present in weak and indefinite form. Since most persons belong to the mixed types, we usually designate these types in terms of their dominating sensory elements. Hence, if we ordinarily employ a somewhat inaccurate terminology and call a man of the mixed type a "visual," that term is usually employed to signify only that visual imagery predominates in his consciousness. He may also be equipped with the other sorts of imagery, but may employ these only in a secondary fashion and with greater indefiniteness. This has come to be the usual meaning of "auditory," "visual," etc., because the mixed types occur so frequently. From the point of view of general psychology, it is a somewhat arbitrary delimitation to designate all of these types of imagery solely in terms of diversity of material content. We can distinguish them quite as well from the formal point of view of individual peculiarity of image-process, or of prevailing form of reproduction. I have elsewhere[1] briefly attempted to broaden the concept of ideational type; more detailed discussion of the matter here would carry us too far afield.

In an investigation of ideational types by means of the method of reproduction I found that the peculiar type to which certain individuals belong is determined by the fact that although they can readily ideate imagery of certain

[1] E. Meumann, *Intelligenz und Wille*, Leipzig, 1908, 128.

sense-departments, each by itself, they are unable to make use of these different sorts of imagery in combination with one another in their ideation and learning. For instance, it was found that one individual possessed definite visual images of objects and auditory images of words; but it was difficult for him to employ them both at the same time in an act of learning. He relied either upon the retention of visual concrete imagery or of auditory verbal imagery; that is, he remembered the appearance of an object or he remembered the sound of its name, but never both together. Another case was found where an observer possessed a good auditory memory of melodies, clangs, timbres of voices and noises; he also had a good memory of forms and a fairly good memory of colors. But it was difficult for him to combine these concrete visual and auditory images. It is probable then, that we can distinguish combination types of ideation; and here the non-combinability of certain images is the best term for the designation of these types. Many defects of endowment of the third order are probably due to these phenomena,[1] because defects in complex functions, such as are concerned in the work of the school-room, must owe their origin to defects of combination. For instance, defective capacity to learn geography may be due either to sub-normal ability to deal with concrete visual imagery (maps and the like); or when normal visual imagery and normal memory of names is present, it may be due to an inability to combine concrete visual images with the auditory-motor images of words.

In another volume[2] I have sought to make a complete

[1] Defects of endowment may be of three orders: first order, defects in the elementary mental processes; second order, defects of complex mental capacity; third order, defects of complex functions.

[2] E. Meumann, *Vorlesungen zur Einführung in die experimentelle Pädagogik*, Leipzig, 1907, I., 449.

schematic classification of the ideational types from the point of view of their content. The schema which is appended here needs no additional comment:

1. Types of Concrete Ideation

A. Pure Types:

- *a. Visual.*
- *b. Auditory*
- *c. Tactual-Motor*—the latter perhaps differing according as they have to do with a motor ideation of movements or of forms. Individuals of this type ideate in terms of imitative, empathetic[1] or copying movements, with or without an actual innervation of the muscles.

  In addition to these three, there are perhaps types which make use of elements from the gustatory and olfactory senses, and of organic sensations.
- *d. Gustatory*
- *e. Olfactory*
- *f. Emotional*

B. Mixed Types: Instances of these types have not been proven, beyond a doubt, to exist.

2. Types of Verbal Ideation

A. Pure Types:

- *a. Visual*—perhaps two forms: ideating in images of

[1] Empathy (*Einfühlung*) is a term which has come to be employed in psychology and æsthetics to designate the general tendency to project oneself into situations in which one is interested, and to experience such sensations as would result from one's active participation in such situations. For instance, when we observe or even imagine a feat of strength, our bodies become set and our muscles become tense; when we see a slender column which supports a heavy capitol, we experience an empathetic feeling of the heavy stress which is borne by the column.

written or printed words; and, possibly, ideating in visual images of writing-movements.

b. Auditory

c. Tactual-Motor—ideating in images of vocal movements; ideating in (kinæsthetic) images of writing movements, with or without innervations of movements.

B. *Mixed Types:* not yet clearly shown to exist.

3. Combinations of Concrete and Verbal Ideational Types

A. *Visual concrete ideation combined with auditory-motor verbal ideation:* This is probably the most common type.

B. *There may be other combinations of 1 and 2 of the above schema:* but they are rare,—indeed the existence of such cases has not yet been demonstrated beyond a doubt.

4. Negative Combination Types in Concrete and Verbal Ideation

A. *Auditory Verbal and Visual Concrete, both well developed, but the two incapable of being combined.*

B. *Auditory Concrete and Visual Concrete, both well developed, but the two incapable of being combined.*

Let me again mention that in the concrete auditory, tactual, olfactory and gustatory memories a similar one-sidedness of development and similar differences of native endowment seem to occur. The endowment of the unmusical individual, who can not remember a tune and who sings only a few notes correctly,[1] and the endowment of a Mozart, who reproduced the *Miserere* from memory after hearing it but twice, vary between quite as wide limits as the extreme cases of visual endowment which we have described.

Of more importance to pedagogy, however, are the typical

[1] Such cases have been cited by Stumpf and by Dodge.

differences which are found to occur in verbal thinking; and these have been more fully investigated by psychology. Following the example of Charcot, writers have usually subdivided them into three, or really four, types. The auditory individual thinks in heard words; the visual, in visual images of printed or written words; the motor, in images of writing movements or in images of former vocal movements which themselves are frequently accompanied by slight but actual movements of the lips or tongue. Observations bearing upon this topic have been made by psychologists these many years. Leibnitz called thinking a silent speaking; and Hartley distinguished the other types in a work which appeared in 1749. More detailed investigations of the characteristics of the various types were first made by Charcot, the director of the Salpêtrière in Paris, and his pupils,—particularly Ballet; later contributions were made by Galton, Taine, Ribot, Binet, Egger, numerous German psychiatrists, physicians and psychologists among whom were Kussmaul, Wernicke, Störring, Ziehen, Pfeiffer, Segal, Kraepelin and his students.[1]

To Charcot must be given the credit of having first pointed out the fact that the verbal images in which most people think are not simple mental processes but that they are composed of at least four,—more correctly, five—different elements: auditory images, visual images, motor images of movements of vocalization or of writing, and ideas of meaning. Besides the three "pure" types which are characterized by an exclusive dominance of some particular sort of imagery in the subjectively spoken words, Charcot also recognized the "indifferent, or mixed" type. We must assume that in the ideation of words all of these types may occur; and individual cases of approximately pure types of verbal imagery of both the auditory and the visual sorts have been shown to exist.

[1] See Bibliography at the end of this volume.

We must also assume that all varieties of the mixed types of verbal ideation are possible. The existence of auditory-motor, of auditory-motor-visual, and of visual-motor types has been demonstrated (Netschajeff). In most persons, however, the auditory-motor ideation of words predominates; and, as already remarked, this is probably an adaptation of the ideational type to the sort of impressions which most frequently occur in the noting of words which are heard in the speech of ourselves and others.

An analysis of these differences is extremely instructive for psychology and pedagogy. Let us begin with the pure auditory type. Individuals who ideate solely in terms of auditory images are very rare. The average normal person can easily observe his ideational type; and among numerous persons whom I have requested to make such observations, I have found not one who employs heard words exclusively in his processes of thinking. Yet it is true that many individuals approximate this type, in that mentally heard words predominate in their thinking and are accompanied by but faint motor images. In the majority of persons there is, in all probability, an alternation of the sensory elements which constitute their internal words. In calm reflection and in reading, the heard and the mentally spoken word predominate, the appearance of the printed word arousing the reproduction of the mentally spoken word. The same state of affairs is found in writing; here, too, the image of internally spoken and externally seen words play a part. But when one writes, the internal words rush along in advance of the act of writing, dictating, so to speak, what the hand shall write. Furthermore, in calm emphatic speaking, the internal word hastening on in advance plays the part of a prompter, as Ballet remarks, telling us in a soft and oftentimes imperfect whisper what we are to say.

What determines the auditory type? We are not to suppose that it is always accompanied by musical endowment. As has already been stated, we may find any particular ideational type existing in combination with an endowment of any other sort of imagery. This is shown by such facts as the following. We know, on the one hand, that idiots and microcephalous children, who belong to the lowest level of intelligence, who can never learn to speak a word, and who do not understand the ordinary conversation of persons about them, certainly do not possess any internal speech; and yet they sometimes have a keen musical apprehension and an excellent memory for tones. I have myself observed an idiot who led little more than an animal existence and who never spoke a word; yet I was astonished to find that he listened attentively to the playing of a music-box and accompanied the melody with rhythmic movements. When the playing ceased, he hummed the melody to himself with a fair degree of accuracy. Nor is there, in the development of the normal child, any coincidence between the development of the tonal sense and the acquisition of language. Tracy established the fact that in many children the tonal sense begins to develop at the age of six months; one of Stumpf's children knew the tonal scale at the age of fourteen months; a son of the composer Dvorak sang a military march at the age of one year, and six months later could sing all of his father's melodies when the latter played the accompaniments on the piano. We find a corresponding state of affairs in adults. Ballet mentions the case of a musician who possessed a remarkably good memory for tones but who ideated words more readily in visual than in auditory form. On the other hand, many persons who have a distinctly auditory ideation of words possess no special gift for music. But, of course, a serious defect of the tonal sense usually gives rise to a non-auditory

ideation of words. These characteristic combinations of ideational types, in verbal thinking and in non-verbal thinking, indicate that our ideation of words is of two wholly different sorts, in so far as its relation to audition is concerned. The auditory ideation of words is either a product chiefly of mere habituation,—in which case it can be overcome by training,—or it is due to a congenital lack in capacity to recall non-auditory images,—in which case a modification of ideational type is possible only to a limited degree.

In an attempt to reach a clearer understanding of the auditory ideation of words the question has been raised: How does the auditory individual hear his internal words? Certain investigators, Egger in particular, have asserted that we normally hear the inflection and the rhythm of our own voices and that, if this is lacking, genuine internal speech is impossible. This statement Ballet very properly disputes. We really hear our own voices only when we reflect, or when in thought we place ourselves in situations where we seem to speak. In addition to this, however, all of our remembrances of other voices which we have heard also come to consciousness when we think of another person as speaking, or when we think of ourselves as carrying on a discussion with another person. Scherer reports that Diderot was an enthusiastic debater and that his abstract thinking always took the form of an imagined debate with an opponent; and Galton has introduced the term "histrionic" or "dramatic" to describe the ideation of this type of individual. It can scarcely be assumed that one's own voice alone is heard in such a case. One would expect that the imagery would be constituted exclusively by one's own voice only when one's type is vocal-motor, rather than auditory because, in that case, the individual is limited to the functioning of his own vocal muscles in his ideation of the sounds of words. And, of course, he

will hear only the sounds which arise from the innervation of his own vocal organs. Our propensity to think in terms of heard or spoken words may be intensified under certain pathological conditions. When the nervous system is over-stimulated we frequently find ourselves impelled to repeat phrases in an automatic fashion. The reader may remember the humorous sketch in which Mark Twain describes the contagious effect of a verse which was used in remembering the street car fares in an American city. Everybody who heard the verse was driven to distraction by it.

What is the relation between ideational type and mental efficiency? A reference to the foregoing discussion of the auditory type will indicate the state of affairs which one may expect to find in the case of the other types. Every variety of motor individual who thinks in terms of vocal images,—and vocal motor images are frequently accompanied by movement innervations,—is intimately related to the auditory type. We have in the literature an excellent introspective analysis of two such motor individuals both of whom were trained psychologists. Dodge, a pupil of Erdmann, has given a detailed description of his own thinking which is almost exclusively motor; and Stricker, a Viennese physician, has devoted several monographs to the analysis of his own internal speech. Dodge has established the fact that his thinking may assume the form either of verbal or of concrete images. The latter form of ideation occurs, for example, when he is planning the construction of a piece of apparatus; in such cases he is altogether visual, and his internal speech retreats completely into the background, excepting when his emotions are vividly aroused and when he is about to utter an exclamation. When, as he ordinarily does, he thinks in verbal terms he pronounces the words mentally but without hearing them. His thinking is therefore a motor speech of

which he has no auditory image. The sensory elements which come to consciousness during the process are images of tactual and kinæsthetic sensations from the muscles of the lips, tongue, mouth and throat, and probably from the thoracic muscles which are concerned in breathing. Auditory elements may appear but only when the ideation is very definite; and even then the auditory images are vague. Dodge has no images of writing movements, nor any sort of visual verbal imagery. Even in voluntary recall, images of writing movements can be evoked only with difficulty. This shows that Charcot was wrong in including persons who think in terms of writing movements and persons who think in terms of vocal movements, in the same category; it shows, too, that "motor type" is but a general name under which numerous variants are to be included. In Dodge's processes of thinking, verbal meanings attach to words which are ideated in motor fashion with weak auditory accompaniments.

Dodge's introspections are especially valuable because his motor-verbal imagery may be traced to a congenital and hereditary lack of auditory imagery; it is, therefore, not merely a product of habituation. His auditory remembrances are "exceedingly scant and indefinite." He says: "I am wholly incapable of recalling the successive sounds of a musical composition." "I am able to sing mentally a few simple melodies, but this singing possesses little besides motor content." He is usually unable to ideate the voices of his acquaintances; the voice of his father can be recalled only in certain phrases, such as "My boy," etc., and only by means of the visual images of the appropriate situations. An opera which has but recently been heard can be rehearsed mentally, but "purely as a pantomime." "The verbal images (of the arias) are motor; the voices of the singers are inaudible." This one-sidedness of imagery is hereditary in the Dodge

family. "My mother and my brother have no more musical memory than I have." "None of us sing." In this case, then, the lack of internal speech is, at the same time, a lack of auditory memory in general. Stricker is even more purely motor than Dodge; and Stricker has analyzed his ideational type with great care in numerous refined observations. He is guilty, however, of two gross errors. In the first place, he regards his own peculiar type as being characteristic of mankind in general; and he is of the opinion that nobody possesses definite auditory and visual memories of vocal and writing movements. Secondly, it is evident from his own descriptions that he thinks in terms of tactual and kinæsthetic imagery; yet he asserts that his ideation of words contains no sensory elements, but consists exclusively of revived motor impulses (innervations of vocal movements). He summarizes his observations as follows: "My ideas of singing are wholly independent of any remembrance of songs which I have heard. The state of affairs is similar in the case of music to what it is in the case of articulate sounds. The auditory impressions which I have experienced are completely forgotten; but still something remains in their stead, something which I did not obtain from the external world but have myself created. My musical ideas, like my verbal ideas, I owe to my innervations of movements."

The other ideational types occur less frequently in verbal thinking. Purely visual individuals, an illustration of whom will be cited presently, think in terms of verbal images which are mentally seen; they read off their words internally, as Ballet describes it. Every person who has learned to read may have such images; but in most persons they play no part in the process of thinking. They make their appearance on certain occasions in the mixed types, as for example, when such a person recalls a passage in a book or a manuscript.

Galton seems to have been the first to establish the existence of this type. Charcot, in dealing with a dominantly visual patient, found that he thought solely in terms of the visual images of printed words. Cases of persons who think in distinctly visual-verbal terms seem to be found most frequently among mathematicians and "mathematical prodigies."

The nature of these types is very clearly shown by an accurate investigation of individuals who possess a decided mental bent in some particular direction. Fortunate circumstances led Binet to make the acquaintance of two noted "calculators" who employed processes of wholly different types in their mathematical operations. Binet first investigated the Italian, Inaudi, whose calculations were made without any participation of visual imagery; then the Greek, Diamandi, who accomplished enormous numerical operations almost exclusively by means of visual imagery. I have had an opportunity to make a study, of several hours' duration, of these two prodigies. Inaudi placed himself at my disposal in the Leipzig laboratory; and Diamandi visited me at my laboratory in Zurich. The results of my tests differ somewhat from Binet's in that he, probably under the influence of Charcot, concluded that Inaudi was a purely auditory calculator,—he called him a "model auditory,"—while I found that he employs internal speech throughout, both speaking and hearing the numbers. And Binet regards Diamandi as a pure visual, while I found that in him, too, a trace of internal speech is present. But my results agree with Binet's in their essential features, particularly in the finding that Inaudi is wholly lacking in visual images and that Diamandi works chiefly by means of visual images. These two mathematical prodigies are excelled by Dr. Rückle, who has been investigated by G. E. Müller. Rückle belongs to a mixed type,

with predominant visual imagery; according to his own statements made to me during a brief investigation, Rückle makes extensive use of mnemonic aids and of the mathematical relations of numbers.

The nature of the special memories, whose investigation has proved to be difficult for modern psychology, cannot be better set forth than by a description of the manner in which the memory of a "rapid calculator" functions. In Inaudi's case it was possible to determine without psychological investigation that he must necessarily do his calculations in a non-visual fashion. He was reared as a shepherd, without any schooling, and remained illiterate until the age of fourteen. When six years old he began his calculations, after an elder brother had taught him to count; and at seven he was able to multiply two five-place numbers mentally. He never needed to have his numbers or his numerical operations written or presented in any other concrete fashion. After he had earned a livelihood for a time by travelling about and giving exhibitions in cafés while his brother played a hand-organ, he went to Paris in 1880. There he came under the observation of Broca, Charcot and Binet; even at that time he was still unable to read or to write. His talents and his interests were then of a wholly one-sided sort. The details of Inaudi's feats cannot interest us here but the following seems to have a psychological significance. His public exhibition usually consisted in multiplying extremely large numbers,—numbers of sixteen, twenty or twenty-four digits. He calculated mentally, while behind him his manager wrote the result on a large blackboard. Inaudi did not see the numbers; the problem must be given him orally because the sight of the figures disturbed him. He did not fear any distraction or interruption during the calculation; indeed lest the demonstration should become tedious to his spectators he even

introduced interruptions. He would ask one of the audience to give the date of his birth, and he would then calculate the day of the week upon which the birthday fell,—all of this while he was still apparently engaged upon his first and chief problem of multiplication. I am convinced, however, that he was really not able to carry on two calculations simultaneously. He simply interrupted the first problem at a certain point and subsequently took it up again at the point where he had left off. But we shall see that this independence of interruptions and distractions is a characteristic of the auditory-motor type.

Inaudi's extraordinary memory for numbers is the chief feature, however, in which he surpasses the ordinary calculator. After an hour's public performance, during which approximately three hundred digits were employed, he was able to reproduce all of the mathematical operations from memory; he was still able to recall them on the following day, even when he had not been forewarned or especially prepared for the delayed recall. And yet his memory was poorly developed in every other direction. When numbers were presented to him orally and he was asked to repeat them immediately afterwards, he was able to recall forty-two correctly,—the limit for other persons does not exceed thirteen; but, on the other hand, he could not repeat more than six or seven disconnected letters under similar conditions, nor more than a very few words of a poem. His memory for musical compositions, for geometrical forms, and for colors was below the average.

It is a remarkable fact that Inaudi does not retain large groups of numbers mechanically, but by remembering the problems in which they occur. This shows that even in this unusual development of a memory for numbers, logical retention plays a leading rôle. If we regard forty digits as approx-

imately the maximum which he is able to retain mechanically and reproduce orally, and regard as his extreme limit of logical retention the results obtained in a sitting at the Sorbonne where he recalled four hundred digits, we find that his memory when reinforced by the meaning of the problem is ten-fold more efficient than his mechanical memory. Ebbinghaus obtained an identical relation in his investigation of the memory of the average individual. Binet's experiments show that the memories of these two prodigies follow the same laws as the memory of the individual of average and normal endowment. The sole difference is a difference of degree.

Inaudi remembers numbers by combining them into successive groups. He forms series of successive auditory-motor impressions which he brings into association with one another, constantly vocalizing throughout. By this means he imprints upon his memory successive groups of spoken names of numbers; or, psychologically expressed, he forms successive associations of the auditory-verbal images and the vocal-motor images of numbers. And in recalling his mathematical operations he always has recourse to a successive re-pronouncing of the imprinted groups. Never does he see large groups of numbers simultaneously before him. Multiplication, therefore, constitutes the basis of all of his calculations because multiplication is a genuinely successive operation. It is probable that in division, when he deals with large numbers, his procedure consists in hitting upon a tentative quotient from his wide experience and then in rapidly testing its correctness by a process of multiplication.

The exact process of his retention was not discovered, however, until an experimental investigation had been made. Binet asked Inaudi to sing a tone continuously during the act of calculating, in order, by this device, to introduce an

auditory-motor distraction. This did not completely destroy his ability to calculate, but it doubled the time required for the operation. I arranged the following experiment: Inaudi was first asked to solve a great number of problems which were as nearly as possible of equal difficulty. Each problem consisted in raising a two-place number, above forty, to the third power. After I had determined from a number of these problems what was the average time required for their solution, I introduced auditory and motor distractions alternately, in the hope of determining exactly what was his mental type. I also set several metronomes in motion; but they did not disturb him at all. Then, too, he was asked to extend his tongue and to hold it between his teeth during the act of calculating,—an expedient which eliminated his internal speech. This variation increased his time threefold; and it was increased still more when the tongue was extended from the mouth. We applied a registration apparatus to his tongue and his larynx and made a graphic record of his vocal movements. This showed that his calculation was attended throughout by uniformly present but faint vocal movements. I was not surprised, therefore, to hear him state that he always found it impossible to calculate well when he was hoarse. Our tests show that he undoubtedly belongs to the dominantly motor type. Yet from his own statements there seems to be no doubt that he also possesses auditory imagery of spoken numbers; if he were a purely auditory calculator, however, he would be distracted by noises. His employment of vocal movements enables him to obviate these distractions.

Diamandi was born in 1880 upon the Greek island of Pylaros. He is descended from an educated and well-to-do family, and he himself was for a time a corn merchant. In describing his method of calculating he states that he sees

the numbers "as though they were photographed" upon a sheet of paper before him, and he reads these visual images. There is no doubt that his calculating is done in a wholly visual fashion; but his statement that the process is of a "photographic" character cannot be accepted without qualification. In the first place, I was able to discover that he, too, was disturbed when his internal speech was inhibited during the process of calculating. The disturbance was slight, however, and he was still able to calculate visually when he counted the strokes of a metronome while engaged upon the solution of a problem. In contrast with Inaudi, who refuses to accept any but oral problems and who never looks at the blackboard, Diamandi demands that his problems be presented in written form. Then he proceeds with two interesting and distinctly separate acts; he glances rapidly over the written problem, closes his eyes and calls up a visual image of the numbers which he saw. Not until this visual image comes to consciousness clearly and distinctly does he begin his calculation. This shows that the images of the numbers are not simply photographed. His procedure consists, rather, in first transforming the objectively seen picture of the numbers into a mental image in the form of his own familiar handwriting, and then calculating by means of this image. It would be directly contradictory to the view held by modern psychology regarding the reproduction of our sense-impressions if the imaging of the digits in the form in which he sees them were a purely objective process to which he himself contributes no part. Memory never works in a fashion which consists simply in retaining retinal images with photographic fidelity; the remembering of visual impressions is possible only because apperceptive processes are superadded to purely sensory processes. Those data of experience which are not consciously

received and brought into relation with our previous store of ideas by acts of apperception are not remembered. Reproduction must always come about under the moulding and assimilating influence of former ideas. A complete and perfect mirroring or reproduction of a complex visual experience is of exceedingly rare occurrence; and we can accomplish, or even approximate this feat, only after numerous acts of apperception have supplemented one another and have tested and corrected our reproduction by comparing it with the original experience. Even Diamandi's memory for numbers, although it is dominantly visual in its mode of operation, does not "photograph" the digits but requires a series of acts of apperception if it is to succeed in retaining and reproducing accurate visual images of them. Binet arranged the following experiment. Digits were written in inks of different colors, and Diamandi was asked to remember both the digits and their colors. Now if the visualizer's process of retention were a "photographic" process he must imprint both the digits and the colors in a single act. But this he could not do; two operations were necessary. He first learned the figures; and then, in a second reading, he learned their colors. Hence we should obtain a wholly erroneous conception of the process employed by the visualizer in calculating if we supposed that he is able to read figures from an internal photograph as one may read them from a sheet of paper. What he really does is this: In a series of successive acts of apperception he transforms the objectively seen figures into purely subjective visual images; and if it is not expressly demanded of him that he shall remember the details of color and of form in the written figures, he will remember only their meaning and value. These visual images, however, enable him to bring to consciousness only a limited number of digits at a time. He then sets about performing

his calculations with these relatively few images of simultaneously "seen" groups of digits.

When we take these facts into consideration we understand the advantages and the disadvantages of the different types of memory. Every difference in efficiency between the two calculators must not be referred simply to differences in their ideational types because, of course, the mathematical talent of the two men may also be different. But if a comparison of their efficiencies should reveal constant and uniform correlations with their memory types, then it would be highly probable that the efficiencies are to be regarded as products of the respective memory types.

It was found, first of all, that in simple calculations Inaudi (auditory-motor type) worked much more rapidly than Diamandi (visual). There was a great difference even in the rapidity with which they grasped the problem. The problem was presented to Inaudi orally and he set to work immediately after hearing it. In the case of Diamandi, however, a noticeable time elapsed before he succeeded in obtaining a clear visual image of the written problem. Secondly, the calculations themselves are much more rapidly accomplished by Inaudi than by Diamandi; in view of the latter's superior mathematical ability one is compelled to ascribe this difference in rapidity to the difference in ideational type. Series of auditory-motor names whose meanings are securely associated can be pronounced and reproduced more rapidly than their visual images can be evoked. In short, the auditory motor calculator is the more rapid; the visual is slower. A single series of twenty-five digits is memorized by Diamandi in three minutes, by Inaudi in forty-five seconds. But this disadvantage has its compensation because the visual memory is much superior to the auditory-motor in other regards. Even in calculating we are not always concerned with abstract

numbers. It frequently happens that we are called upon to deal numerically with concrete magnitudes, as in simple and higher geometry, in all operations with equations, in all cases where one deals with curves and in numerous applied computations. So soon as spatial arrangement comes in for consideration, even if it be of the simplest sort, we find that the relationship of rapidity between the two types of computation is reversed; now the visual calculates much more rapidly than the auditory. Binet found that for the memorization of twenty-five simple numbers Inaudi required forty-five seconds, Diamandi three minutes. When asked to reproduce the twenty-five numbers in their original order, Inaudi required sixty seconds, Diamandi thirty-five seconds; for reproduction in reverse order Inaudi required ninety-six seconds, Diamandi only thirty-six seconds. In other tests it was found that numbers presented in the form of a square or of a spiral were readily memorized by Diamandi, who was also able to recall them in any order because he imaged them visually. Inaudi was almost wholly unable to accomplish either of these tasks; and when he did succeed he did so only by means of laborious and complex auxiliary operations. From this again it is evident that a memory which is to be capable of meeting all of the demands made upon it must make use of every sort of imagery, at least it must make use of auditory and visual images, that is, words which are both mentally seen and heard. Here again Rückle far excelled the other two prodigies because he made use of reflective processes, especially in complicated operations. For instance, after twice reading forty-nine numbers arranged in seven equal columns Rückle was able to recite them in any desired order,—a feat which neither of the other prodigies could accomplish.

For the sake of completeness it may be mentioned here

that pathological observations have furnished much information regarding ideational types. Investigations of aphasia (disorders of speech), alexia (disturbances of ability to read), and agraphia (disturbances of ability to write) come in especially for consideration here. It is significant that intellectual disturbances of these sharply demarcated sorts may occur in a consciousness which is otherwise relatively unimpaired. They confirm the view that internally spoken words are, like audible speech and ordinary writing, a product of complex functions; that the component processes of which they are composed may, in general, be correctly specified by specifying the ideational types; that in most persons the auditory-verbal image and the vocal-verbal image play the leading rôle in verbal thinking; and that these component processes of verbal thinking are to some extent mutually dependent, although they are to some extent independent of one another. The one-sidedness of mental endowment which we have described is therefore confirmed by the results of pathological investigation.

Among pathological observations there is a noted case which led Charcot to the discovery of ideational types. The case is interesting also for the reason that it furnishes an illustration of substituted or surrogate images. This patient, a teacher, had formerly possessed a very highly developed visual imagery, but he had lost it almost completely as the result of an illness. When he wished to recall complex visual impressions, such as the appearance of familiar persons or places, he found it necessary to have recourse chiefly to auditory imagery, which now came to consciousness as a substitute for the missing visual images. This, of course, as one might expect, resulted in a general decrease of the patient's efficiency of memory.

These clinical observations do not, unfortunately, give us

an adequate insight into the extent to which the ideational type is changed as a result of such a partial loss of imagery. Such an insight is especially desirable because it would clear up the question of the modifiability of ideational type. Still pathological observations always seem to show that other images which formerly served in a subsidiary capacity may take the place of the missing imagery. Something of a similar nature is found to occur in the normal individual of the mixed type when, in order to adapt himself to a particular sort of presentation, he works with a sort of imagery which he has but slightly developed.

During the past few years the pedagogical significance of individual types of ideation has been made the subject of several important investigations. Before we can apply the results of these experiments to the work of the school-room we must first determine: *1.* Whether different types occur in children as they do in adults; *2.* Whether typical modes of ideation are capable of being modified by training; and *3.* What significance these differences of type have in the work of memory. *4.* It is also essential that we should have reliable and convenient methods for the determination of the ideational types of children.

As for the first question, the investigations of Ziehen, Netschajeff, Lobsien, Pfeiffer, Eckhardt, Lay, Pohlmann, and others, as well as experiments which I have made upon school-children, show that the concrete-objective ideation of the child, up to the age of about thirteen or fourteen years, is always more particular and visual than that of the adult; that is, children of school-age think in terms of concrete images of particular objects, persons and occasions which are frequently localized spatially and oftentimes temporarily also, while adults think chiefly in terms of general verbal ideas. Girls make greater use of visual imagery than boys of the

same age; and the visual memories of girls are more diversified and definite. This characteristic difference between the sexes seems also to persist throughout later years, for Cohn's investigations of the ideational types of adults show that women are more dominantly visual than men. And Wreschner also shows that women's testimony regarding their visual experiences is more abundant and more accurate than that of men.[1] Now this seems to indicate that the child's mode of ideating is usually concrete-visual; but it does not determine whether a dominantly and distinctly visual type of ideation exists in childhood.

We cannot infer from the foregoing that verbal thinking must also be more visual in children than in adults. The ideational types seem rather to occur with about the same relative frequency in adults and in children.

It is unfortunate that no statistical investigation has ever determined, with sufficient comprehensiveness, what is the relative distribution of ideational types in children and in adults. In the work of Lay and Pfeiffer a beginning has been made; and in my own laboratory the ideational types of about forty children have been examined. The investigations of this problem by Pfeiffer at Würzburg are instructive; but they deal with only about fifteen girls, whose types were very carefully examined in each of three successive years. Pfeiffer's averages for the three years show that about forty-five per cent. of the group were visual, twenty-five per cent. were auditory and thirty per cent. were motor,—these data referring to concrete objective ideation. Here again the visual type predominates.

As to the second question,—whether the ideational type may be trained or transformed,—I believe that we must answer in the affirmative for we found that in our experi-

[1] See Bibliography at end of this volume.

ments the type is frequently changed by the use of a particular method of learning which was employed for only a few weeks. This particular mode of learning, which consisted in reading lists of words *sotto voce*, had a transforming influence upon the type, usually in the direction of intensifying either the auditory or the motor elements or both. Thus all of the observations which affirm the variability of the types also testify to the possibility of modifying them by training. A number of such observations were reported in earlier investigations. Ziehen found a boy who, when words were presented orally, always made use of visual images of written words because he had been taught to spell by the visual method. Pohlmann even found that every sort of training develops a special responsiveness to particular modes of presenting material. Such a specific responsiveness to particular sensory impressions, however, presupposes that a specific training of sense-memory has taken place. Queyrat reports that in ideating the song of Lucrece he has a visual image of the printed verse; when he recalls the Marseillaise he has an auditory image of its words; and when he remembers a conversation the images of vocal movements predominate. This shows us that the dominating sense-elements employed in ideating any material correspond to the method employed in learning the material. The same phenomenon is seen in Baldwin's statement that he ideates the German language in vocal-motor and auditory terms because he learned it by conversation in Germany, while he ideates French in visual and manual motor terms because he learned it in the classroom. Pfeiffer found that the influence of our everyday life, especially of our vocation, also moulds our ideational type by a process of habituation and practice; and Lobsien reported that the type of concrete ideation varies with age.

All of this shows that ideational types are plastic and edu-

cable; but we do not yet know what are the limits of their educability. Our conception of the modifiability of ideational types must conform with our general conception of the modifiability of natural aptitudes. Every natural aptitude is of a dispositional character. Dispositions can, in general, be intensified by training in proportion to their original congenital intensity, strong dispositions being more easily strengthened by practice than weak ones. The effect of practice, then, is limited only by weakness of disposition, or by complete absence of congenital bent. This accords with our experience that the mixed types are more variable than the pure types, because, in the former, dispositions towards several sense memories are present. Pfeiffer found that the pure type shows a greater stability, but his finding is a phenomenon of development rather than of training; and I cannot grant that Pfeiffer's alleged pure types are really pure. Moreover, the question as to the possibility of training ideational types will also depend upon their connate character. The view which we have here presented affirms that they may be trained. Wells[1] has called attention to the significant phenomenon that all such questions are intimately related to the individual educability and "practice-ability" of the particular individual; and educability and "practice-ability" are for Wells, as they are for Kraepelin, fundamental differences in mankind.

Let us now examine the methods which have been employed for the determination of ideational types. A consideration of these methods seems likely to throw still more light upon the nature and the pedagogical significance of the types themselves. We have not yet discovered a perfectly satisfactory method for the rapid and reliable determination of

[1] F. L. Wells, The Relation of Practice to Individual Differences, *Amer. Jour. Psychol.*, XXIII., 1912, 75–88.

ideational types. The methods which have been in current use are ingenious devices rather than accurate and systematic methods. The method of distractions and aids combined with the reaction-time method gives the most rapid and the most reliable results. In this procedure the observer is given a number of definite memory tasks of equal difficulty and the time required to accomplish each task is measured. By this means we are able to determine the amount of memorial work accomplished and the time required for its accomplishment. Then aids and distractions are introduced with a view to helping and hindering the work of memory; and these are so chosen that the means which are employed in the special memories and which constitute the observer's type may be aided or hindered. In this way we determine whether the time required to accomplish a given amount of memory work is decreased or increased, and what is the relative amount of decrease or increase in different individuals. For instance, an observer is asked to memorize groups of numbers or letters or to recite them immediately after he has read them. By this means we are able to discover the maximum of numbers or letters which he just succeeds in memorizing, and to measure the time which he required for their memorization.

Now we assume that the auditory individual is distracted more by the presence of auditory stimuli, the visual by visual stimuli, and the motor by the inhibition of his internal speech. One would then expect that the possession of a dominantly visual type of ideation would be revealed by the fact that memorial efficiency is not essentially impaired by an inhibition of internal speech; and that the presence of a motor type would be disclosed by the fact that an inhibition of vocal movements almost wholly destroys the capacity to memorize. As Segal has pointed out, this method can yield unequivocal results only when it is supplemented by variations in the mode of

presenting the material, and when we take into consideration whether the material is mentally reproducible in single or manifold fashion. Just as, by this method, we introduce distractions, so we may also introduce aids or helps to memorization. For instance, the visualizer may be identified from the fact that his retention is materially aided and strengthened by a distinct spatial arrangement of the material which he is to reproduce; and this aid is non-effective or even negative in the case of the auditory individual because the latter must now form successive groups of impressions, and a definite spatial arrangement of the items to be remembered may hinder his procedure in memorization. The following phenomena furnish additional means of determining the type to which a given individual belongs. The visualizer can readily reproduce visual impressions in transposed order; the individual who is dominantly auditory-motor finds that such a transposition is a difficult feat. The visualizer confuses letters and words which look alike, although they may have wholly different sounds; the auditory-motor individual confuses letters and words which sound alike although they may not look alike. The Frenchman who wrote "*droit*" where he intended to write "*trois*" clearly belongs to the auditory type. In learning lists of words the visualizer is more likely to note the consonants, the auditory individual the vowels. The visualizer remembers positions upon the pages of books, the auditory-motor does not. The visualizer spells long words backwards almost as readily as forwards; the auditory and the motor individuals find this to be a much more difficult task. For a more detailed discussion of these methods I must refer the reader to the special literature of the topic.[1]

The foregoing discussions indicate that the memory type

[1] See E. Meumann, *Vorlesungen zur Einführung in die experimentelle Pädagogik*, II.

of the pupil should be taken into account by the teacher. I once observed a boy of thirteen who was trying to draw an outline map of Greece. Although he had made an accurate study of the map, his drawing did not show the characteristic outline but only a shapeless form which bore no resemblance to the map of Greece. I surmised at once that he belonged to the motor type and had him trace the coast-line with his finger, at first in sections and then as a whole. He was then able to make the drawing accurately and without any difficulty. A study of his ideational type would have been beneficial both to him and to his teacher. Binet also has determined that certain persons must trace a drawing with the finger if they are to remember it. And a certain French painter employs this method in teaching his art. "In order to accustom his pupils to drawing from memory, he had them follow the outline of the figure with a lead pencil held at some distance from the eye; and he thus obliged his pupils to fuse the motor remembrance with the visual remembrance" (Ballet). While a student in the high school I studied Hebrew; but since it was my custom to remember vocabularies by means of auditory images I had great difficulty with Hebrew verbs because they are all so similar in sound (a long *a* in the first syllable and a short *a* in the second). It occurred to me to attend only to the visual images of the consonants and my difficulty disappeared.

These are only indications of the pedagogical applications which may be made of the doctrine of memory types. We shall learn more of them in our discussion of methods of learning.[1]

[1] Concerning the significance of ideational types in the general work of teaching, see L. Pfeiffer, *Op. cit.*, 120ff.; for their significance in mathematics, see R. Eckhardt, Visuelle Erinnerungsbilder beim Rechnen, *Zeitschrift f. exp. Pädagogik*, V., 1907, pp. 1–22; for their significance in language instruction, see L. Pfeiffer, *Ueber qualitative Arbeitstypen*, Leipzig, 1908. Pohlmann and Lobsien may also be consulted.

CHAPTER VI

ASSOCIATIVE LEARNING (*Continued*)

3. Economical Learning

Economical learning is that sort of learning which attains its end in the most appropriate and advantageous fashion. The end usually consists in an ability to recite from memory and to retain permanently in memory; and the most advantageous method is the method which employs the least time, and which employs the simplest and most appropriate procedure. The aim of learning, however, is not always the same, as we have already seen. In school-work the act of learning aims to secure an ability to recite the material once from memory, and then to retain the "substance" of the acquired material either temporarily or permanently. In certain cases we endeavor to memorize word-for-word; in other cases our sole purpose is to learn the essential content of a coherent context or a mass of concrete material without regard to the author's wording. The concerns of practical life and the affairs of the school-room frequently impel us to learn material with a view to remembering it for only a short time. When a professor prepares for a lecture, a public speaker for an address, a preacher for a sermon, or an actor for a performance, permanent retention is a matter of but slight importance. Hence it is preferable to extend the significance of the term "economical learning" to include every sort of learning which reaches its goal with a least expenditure of time and of energy and by means of associations whose formation conforms with sound psychological principles.

In practical life and in the school-room, significance attaches

chiefly to three of the numerous conditions of learning: the expenditure of time, the expenditure of energy, and the method of forming the associations which are to be effective in subsequent reproduction. The amount of time which is expended in learning can be measured without difficulty. In measuring expenditure of energy we first of all determine how many repetitions are necessary to secure a first errorless recitation; then we determine the intensity of concentration, and finally the degree of fatigue which is produced by the act of learning. The effect of the act of learning may be measured in various ways; we may determine it from the first errorless recitation, or from subsequent recitations made after the lapse of variable intervals of time or, when reproduction is no longer possible, we may measure how much time or how many repetitions are saved when the same material is re-learned after various intervals of time. When the method of relearning is employed we may supplement it by other methods of measurement, such as the method of paired associates which has already been described. Ebbinghaus developed a method of prompting, in which the learner signals that he is in need of aid and is then supplied with the name of the missing word or syllable; the number of promptings is taken as a measure of retention. But this method is not to be recommended.

If we are to obtain an insight into the nature of the methods of learning it is indispensable that we should make an independent investigation of every factor or condition which has to do with the work of memory. And for this reason the saving of time, the saving of energy, and other phases of the problem of learning has each been made the topic of a special investigation.[1]

[1] For a discussion of the meaning of economy in learning see Appendix II.

It will be less difficult to give a clear description of the methods of learning and of the means which have been employed in investigating them if we first present the successive stages through which the development of memory experimentation has passed. Then we shall add a summary statement concerning the significance which these experimental results possess for the teacher.

Let us observe a pupil and note how he proceeds when he is assigned the task of memorizing a poem, or of learning words of a foreign language. Notwithstanding certain differences in individual methods of learning, it will be found that most pupils commonly adopt the same procedure to the extent, at least, that they break up the prescribed material into smaller sections, especially if it be a long task; then they learn each of the sections by itself, by a process of repeating it over and over again; and finally they connect it all together by reading the whole material through from beginning to end. For instance, the pupil divides a stanza of poetry into two or three parts which vary in length with the content, the sentence construction, and the length of the stanza; and each part is memorized independently. Most pupils memorize foreign vocabularies by a process in which each word with its equivalent in the mother tongue is learned by a series of repetitions of the single pair of words. Seldom do we find a pupil who proceeds in any other fashion, for instance who reads the whole poem or the whole list of words through from beginning to end and by always reading in this fashion attempts to memorize it as a whole. And yet general psychological considerations as well as experimental findings show that the latter method is the only one which is psychologically justifiable and that it is by far the more economical. That is, the "whole" method requires fewer repetitions and usually less time than the "part" method to produce a first

errorless recitation; and, what is still more important, the "whole" method secures a more accurate reproduction and a more lasting retention. From this it would seem to follow that pupils should be induced to learn material as a whole and never in parts. It is especially true of the pupil whose memory is weak and whose reproduction is uncertain and hesitant that a much more faithful reproduction and a more enduring remembrance is attained by the "whole" method. Since not only in school-children but also in most adults the "part" method is the one most frequently employed, we must devote a more detailed discussion to the surprising experimental result which has just been described.[1]

In order that the methods of learning may be designated as accurately as possible, we shall introduce the following terms: The ordinary procedure in which the learner divides his material into sections and learns each section by itself and then proceeds to learn the whole as a whole, we shall call the part-procedure. But when he reads the material through from beginning to end during the whole process of learning, we shall speak of his method as continuous learning or the whole-procedure.

Even in the earliest systematic investigations of memory Ebbinghaus found an indication of the difference between these two methods of learning; but Ebbinghaus reported only that with material whose parts are of very unequal degrees of difficulty the whole-procedure probably requires

[1] From questioning my acquaintances I have found that in certain individual instances children and adults have instinctively hit upon the use of the "whole" method in their learning of all sorts of material; one of my colleagues reports that he has employed this method since childhood. In his monograph on retention and forgetting, Radossawljewitsch reports that the national singers of Servia learn all of their songs and poems by the "whole" method (*Op. cit.*, p. 93); and I have heard that certain primitive peoples know no other method of learning.

somewhat more time than the part-procedure.[1] We shall see that this is sometimes true of materials whose parts are exceedingly non-uniform in their degree of difficulty; but this does not prove the falsity of our principle that in general the whole-procedure is more economical than the part procedure. It was G. E. Müller who by his experiments upon the learning of nonsense syllables first instigated the more accurate investigation of this problem; and it was Lottie Steffens, a pupil of Müller's, who although her investigation was not wholly complete first showed that under certain circumstances it is more advantageous to learn an extensive material as a whole. The differences between different methods of learning and especially their effects upon permanent retention have been investigated, in normal individuals, by Pentschew, Ebert and Meumann, Ephrussi, Neumann, G. E. Müller, Witasek and others, and in the insane, by H. Müller.[2] Miss Steffens worked almost exclusively with adults, although a nine year old boy and a ten year old girl were included among her observers for purposes of comparison. In all of the investigations in my own laboratory we experimented with both children and adults, and we adopted a strictly comparative procedure.

Miss Steffens first determined what procedure adults naturally and normally adopt in learning a poem of nine lines. In order to discover how they distributed their repetitions over the material, she introduced a most ingenious device. Stanzas of poetry were read half-aloud and memorized by seven adults; during the progress of the learning the experimenter indicated upon a duplicate sheet what sub-divisions the reader made in the stanzas during his process of learning. If, for example, the first four lines were read through five

[1] H. Ebbinghaus. *Ueber das Gedächtnis*, Leipzig, 1885, 69.

[2] See Bibliography.

times at the outset, this fact was recorded by drawing five vertical strokes in the margin beside these four lines. Hence "the length of the strokes indicated the section of the poem which was included in each repetition, and the order of the strokes indicated the order of the repetitions." Similar records were also made for the boy and the girl. The following characteristic features of procedure in learning were discovered: *a.* In the process of memorizing poetry every learner divided the stanza into parts. *b.* In memorizing subsequent parts they all went back occasionally over the parts which had already been learned and re-read these once more, partly for the purpose of delaying the onset of forgetting, and partly for the purpose of linking up the several sections which had been learned independently of one another. *c.* Every learner repeated the earlier lines more frequently than the later ones; children wasted many more repetitions of the earlier lines than adults. *d.* The more difficult passages and words were memorized by special repetitions. *e.* The end of a section which had been learned by itself, and the beginnings of the succeeding section were linked together by extra repetitions. *f.* Adults showed a general tendency to learn by attempting to recite what had been half memorized, meanwhile looking back occasionally at the original for purposes of control; children learned solely by means of reading. *g.* The act of reading was slow in proportion as the material was difficult.

Miss Steffens paid particular attention to individual peculiarities in learning. Different individuals seem to have wholly different habits in their mode of distributing their repetitions over the material. Some read the whole stanza through at the outset and do not divide it into sections until this has been done; others attempt at the very outset to learn a part by itself, etc. The chief difference between the

child's method of learning and the adult's consists in the fact that the child distributes his repetitions in an exceedingly unpractical and uneconomical manner. The child wastes a great many repetitions upon the first few lines of the stanza, and learns the latter part of the stanza in a very imperfect fashion. Such a method of memorization must, of course, result in a wholly non-uniform learning of the material. This uneconomical distribution of repetitions and certain other consequences of the part-procedure give rise to a hesitating recitation and to a non-uniform retention.

What causes have given rise to the customary methods of learning? Why do most people learn in a manner which is psychologically incorrect and uneconomical? The chief cause is probably to be found in the fact that the various parts of materials to be learned are not all equally difficult. We first of all attempt to learn the more difficult parts separately; and in so doing we break the whole into sections. An additional reason is to be found in the fact that we are naturally indolent; we see the progress of our learning more readily when we learn smaller parts by themselves than when we attempt to memorize the whole at once. Then, too, certain individuals deliberately refuse to learn the whole material at once; they do not feel that they are equal to such a task. We found interesting illustrations of this natural repugnance, some of our adults declaring that the whole-procedure is nonsensical, but they later discovered to their astonishment how successful it is. There are other secondary causes which have given rise to our customary methods of learning; for instance, Miss Steffens expresses the opinion that our learning is not always dominated by economical motives but also by æsthetic and other motives which are at variance with economical considerations. Experimental investigation shows us, however, that the customary methods of learning are psychologically wrong

and unpractical; that the whole-procedure secures a more advantageous formation of associations; that it leads to memorization more rapidly and with fewer repetitions; and that it guarantees a more uniform and lasting retention.

As we have already remarked, Miss Steffens proved only that the whole-procedure leads more rapidly to its goal. This was first investigated by means of stanzas of poetry of as nearly equal difficulty as possible. Selected stanzas were learned by several persons, first by the part-procedure and then by the whole-procedure. The differences in time although not always large were in favor of the latter method.

Her averages show that the learning of a verse by the whole-procedure required 167 seconds, by the part-procedure 183 seconds. A similar investigation of the purely mechanical learning of nonsense syllables was also made. Here, too, there was a slight difference in favor of the whole-procedure. The children's results were, on the whole, the same as those of the adults. Miss Steffens also attempted to determine whether the whole-procedure is also more advantageous when the memory material is of large amount. Her results furnish an affirmative answer to this question; even when long lists of nonsense syllables,—up to twenty syllables in a series,—were learned by the two methods, the whole-procedure usually led to errorless recitation in less time than the part-procedure.

Miss Steffens then raised the question: Upon what does the advantage of the whole-procedure really depend? A group of special experiments, which dealt with this problem, showed that the whole-procedure possesses the following advantages: *a*. When poetry or prose is learned in sections, a special act of learning must be devoted to the transitions from one section to another. The special repetitions expended in this fashion are extra; they are not needed when we learn by the whole-procedure. *b*. When we learn by the part-

procedure we establish numerous associations which must have an injurious effect in our subsequent recitation; in turning back from the end of any section to its beginning we establish an association between the end and the beginning of the same section instead of associating the former with the beginning of the following section. These associations are an impediment to reproduction; and we must suppress them artificially by a special learning of the transitions themselves. *c.* When a material has been learned, not only are associations established between parts which immediately succeed one another but parts which are widely removed from one another are also linked together by mediate associations; and in learning the individual parts of our material we also note the positions which they occupy in the whole. These two aids to memory,—mediate association and "absolute position,"—are reinforced by every complete reading during our process of learning the material as a single whole. But when we adopt a discontinuous and disjointed method of learning, these two advantages are decreased or wholly eliminated because the first few lines are now wholly disconnected from the succeeding lines, since each is learned independently, and the position of the parts is continuously altered and shifted. For instance, at the outset the first few lines of each section occupy the initial position; but so soon as the parts are linked up in a whole they assume a new position. *d.* When we learn by the whole-procedure, our learning is uniformly distributed over all parts of the material; and if the parts of the poem are approximately equally difficult, the whole poem is learned more uniformly. Hence the method itself guards against our devoting too many repetitions to certain parts, and paying too little heed to other parts.

Miss Steffens' investigation was not sufficiently complete to furnish a final verdict regarding methods of learning.

Beginning with the summer of 1901 we undertook an extensive series of experiments in the psychological laboratory at Zurich. These experiments dealt with the technique and economy of learning, their chief purpose being to discover the exact meaning of economical learning as discussed at the opening of this chapter. Accordingly our investigations dealt with three main problems: *1.* Which method of learning leads to faultless recitation from memory in the shortest time and with the least number of repetitions? *2.* Which method of learning secures the best distribution of attention over the material, and the best formation of association between its parts? *3.* Which method gives the most accurate reproduction and the most lasting retention? Our investigation throughout included a comparative study of children and adults. In the experiments which were devoted to the above three questions we employed five school-children,—two boys and three girls, eight, ten, eleven, twelve and fourteen years of age. The later experiments, particularly those of Meumann and Ephrussi, were concerned especially with the significance of the different methods of learning for different sorts of memory material.

We first took up the ordinary part-procedure and asked ourselves the question: Is it more expedient and more economical, in the sense described above, to divide the material into few or into many parts? For instance, when four stanzas of poetry are to be memorized, the question arises as to whether it is more advantageous to learn each of the four stanzas by itself or to sub-divide the poem into still smaller parts. Our experiments showed that learning by parts becomes more and more disadvantageous the more we subdivide the material. And conversely, the more closely part-learning approximates to whole-learning, the more rapidly and certainly is the task accomplished. Furthermore, we

inquired whether the superior advantage of the whole-procedure increases with increase in the amount of material to be learned. Our experiments showed that in the case of adults the advantage of this method becomes more evident with increasing amounts of material. For instance, if groups of 12, 16, 20 and 24 syllables are learned by each of the methods the saving in time and in repetitions, and the increased retention resulting from the employment of the whole-procedure are great in proportion as the group is large.

If, now, the learning which is usually done in memorizing nonsense syllables is regarded as a purely mechanical memorization which derives no aid from the meaning of the material, and if the memorization of poetry is regarded as significant learning, we find ourselves confronted by the question: Is the whole-procedure more advantageous in mechanical learning or in significant learning? We discovered that the greater advantage is derived in the case of significant learning. The differences between the two methods of learning are present in unmistakable degree only in cases where we learn significant material, but they are here very considerable. For instance, one of our observers, *Kl.*, learned two stanzas from Schiller's "Dido" on each of ten consecutive days; on alternate days,—first, third, etc.,—she employed the part-procedure, and on intervening days the whole-procedure,—each stanza constituting a "part" in the former case. It was found that the whole-procedure showed an average saving of 14.5 minutes per stanza over the part-procedure. Thus even with such a relatively small amount of memory material as two stanzas of this poem there was a very considerable saving of time. Subsequent reproduction showed that the stanzas which had been learned as wholes were retained in memory with greater tenacity and were recited from mem-

ory with greater certainty. The number of repetitions employed in the two cases reveals a similar state of affairs. The part-procedure required thirty-three repetitions for the memorization of each pair of stanzas, while the whole-procedure required only fourteen repetitions,—less than half the number of repetitions for the learning of the same amount of material. Moreover, the usual hesitancy in recitation did not occur at the beginnings of sections or of stanzas when the whole-procedure had been employed. The superior advantage of this method appeared again when free reproduction was no longer possible; the partially forgotten stanza was re-learned more rapidly in those cases where it had originally been learned as a whole.

Still another illustration of the difference between the two methods of learning material of moderate length may be cited. One of our observers, *Kel.*, memorized five eight-line stanzas of poetry each day for several days,—employing the part-procedure and the whole-procedure alternately. He required thirty-two minutes, and forty-five repetitions for the memorization of each stanza when the part-procedure was employed; he required only twelve repetitions, but approximately the same amount of time when he learned the stanzas as wholes. This case is particularly instructive because it shows that the advantage derived from the use of the whole-method consists not so much in a saving of time as Miss Steffens believes, but chiefly in a saving of repetitions, in a more correct formation of associations, and in a more permanent retention. It frequently happens that notwithstanding a considerably lesser number of repetitions, the gain in time from the use of the whole-procedure is not great, because most persons involuntarily read more slowly and more emphatically when they employ the whole-method. The difficult passages are read with especial slowness in order that thev

may be imprinted upon memory with maximum concentration during every reading.

The essential advantage of learning by means of the whole-procedure does not come to light, however, until we examine the mental factors which come into play in the two methods,—especially the behavior of attention and the formation of associations. If all the parts of the material are of approximately equal difficulty, then the circumstances which Miss Steffens found to contribute to economical learning must be taken into consideration: *1*. The associations between the various parts of the material must be of a more uniform degree of stability because the whole-procedure provides that the repetitions shall be uniformly distributed over the whole material. *2*. The associations established by the whole-procedure are formed in the direction and only in the direction in which they are subsequently to operate in reproduction; while the part-procedure establishes backward associations between the end and the beginning of the same section. In the former case, reproduction progresses smoothly and without hesitation at the points of junction between the several sections. *3*. The association of each section with its position in the whole body of material is formed correctly from the outset and is reinforced by each successive reading. As a result of this the remembrance of position becomes a most effective aid in reproduction. *4*. In the learning of significant material our apprehension of the meaning and of the logical coherence of the material is much more effective in the formation of associations when the whole-procedure is employed. It is clear that the meaning of the whole is much more readily comprehensible and is much more permanently present in consciousness when we read the material through from beginning to end than when we read each part separately. Even the separate parts are themselves more readily

understood when they are always interpreted from the whole. The advantage which learning derives from an understanding of the meaning of the material is so great that the efficiency of significant learning is found, under certain circumstances, to be ten times as great as the efficiency of mechanical memorization. When we have recourse to the part-procedure, therefore, we eliminate the most potent factor which can contribute to learning. 5. The clearer apprehension of the coherence of material learned by the whole-procedure gives rise to a much more efficient behavior of attention. Since the attention is continuously attracted by the meaning of the material its tension does not relax so readily and a uniform degree of concentration is preserved. In consequence of this, automatic and purposeless recitations are not so likely to occur; they are, of course, almost wholly ineffective for memorization. This chiefly explains why fewer repetitions are necessary when the whole-procedure is employed; every repetition is fully utilized because the concentration of attention has been maintained throughout.

It was the special aim of our investigation to determine whether these differences between the two methods of learning, which we found to occur in the adult, are present also in the child. We discovered, to our surprise, that the differences are not duplicated in all of their details. If we are to understand this we must bear in mind that the memory of children of school-age, up to fourteen years, is a much less efficient instrument than that of the studious adult who constantly exercises his memorial functions. This is particularly true of the mechanical memory of children. The view is universally held by students of pedagogy and psychology that the mechanical memory of children is superior to that of adults, except perhaps in the case of very young children. Our experiments have convinced us that this view is erroneous.

In comparing the memory of the child with that of the adult we must distinguish between two different capacities: the capacity to learn and the capacity to remember. The child's capacity to learn is inferior to that of the adult; but what has once been learned is retained better by children. Yet we have evidence which proves that even in young children, under the age of five or six years, retention is less permanent than in adults. This is to be inferred from observations that children who become deaf before the age of about six years also lose the power of speech and must thereafter be educated as deaf mutes; it is also found that children forget their mother-tongue when they emigrate to a foreign country while adults never forget their native language.

We do not yet know at what age the child's retention becomes superior to that of the adult. Experiments have shown, however, that material which has been learned either mechanically or significantly is retained better by school-children than by adults, and that adults memorize much more rapidly than school-children.[1] Adults who constantly exercise their mental functions are able to learn much more rapidly than children. The inferiority of the child's memory, especially its inferiority in verbal memorization, always astonished us anew when we compared the efficiency of students and instructors with that of school-children. This inferiority was indicated in the results of Bolton's investigation of the development of memory in children. Bolton pointed out that the development of memory depends much more upon the age than upon the intelligence of the child. This means that his physiological age prescribes a definite limit which the memorial efficiency of even the intelligent child cannot transcend, and that older children excel younger children simply because they are older.

[1] Radossawljewitsch (*Op. cit.*) has amply demonstrated this fact.

This seems to indicate that the adult,—in our investigations, the adults varied between twenty and forty-six years of age,—must possess a capacity to learn which is superior to that of the child of fourteen years or less. But is this not contradicted by the familiar experience that capacity of verbal retention decreases with age, and that children learn mechanically more readily than adults? Before I became an experimental psychologist I once observed that a long geometrical demonstration was committed to memory by a child because he failed to understand it. I then made an attempt to memorize the same demonstration word-for-word and succeeded only with the greatest difficulty. Similar observations could be cited by every teacher; but they do not prove what they are alleged to prove. All of our mental functions owe their efficiency to continuous training. The adult has habituated himself to learn by meaning alone, and to retain the content alone. This habitual procedure forces his mechanical learning into the background; but it does not entail a loss of his capacity to retain in a mechanical fashion. Hence, until he reaches a very advanced age the adult can, by a brief training, so restore his neglected mechanical memory as to become able to learn more than three or four times as rapidly as the average child of even the higher school grades. Ebbinghaus found that his own capacity to learn had not declined at the age of fifty-two years. This, however, refers only to learning, not to retention. By simply re-training himself in learning the adult becomes capable of learning every sort of material in less time, with fewer repetitions and with less fatigue; but he does not retain it so faithfully as the child.

The experimental psychologist has a confirmation of both of these phenomena in the quantitative comparative investigations of the memories of adults and children. The memori-

zation of a series of sixteen to twenty-four nonsense-syllables is perhaps the best example of mechanical learning which can be conceived; in the accomplishment of such a task adult learners above the age of twenty years are, after a brief practice, considerably superior to children up to the age of fourteen years. Lists of twelve syllables fatigue the younger child; eight-year-old children are usually unable to learn a series of sixteen syllables at a single sitting, even though they continue their efforts until they are exhausted. The practised adult, on the other hand, learns series of twenty-four and more syllables at a single sitting without serious fatigue. Then, too, it is not only lack of practice in learning by rote which usually impairs the mechanical memory of the adult, but rather the direction of his interest which goes out to the meaning of what he learns and endeavors to seize upon only the particularly important items or upon the æsthetically pleasing features of the material. When, therefore, an adult is asked to commit to memory a passage of prose, we invariably find that it is more difficult for him to abandon the accustomed direction of attention upon the content and to turn his attention to every individual word of the material. The fact that with practice the adult very soon becomes more efficient than the equally practised child is doubtless due to several causes. In the first place, all secondary conditions of learning, especially the concentration, the intensity and the uniformity of attention, are less highly developed in the child; then, too, the adult tires less readily,—he has more endurance, energy and self-control. And finally, when significant material is presented the adult's more rapid comprehension of its meaning aids him, together with a wealth of secondary associations which he is able to attach to the words.

The fact that children excel adults in the retention of sim-

ilar material, learned under similar conditions, comes to light in experimental investigations, especially in the finding that, in re-learning, the saving in repetitions is relatively greater than in the case of adults. And this difference in efficiency increases with increase of time intervening between learning and re-learning; it is also greater for children of seven years than for children of thirteen or fourteen years. Thus we find the same difference within childhood itself; the younger the child (it has been proved up to seven years) the less easily does he learn by rote but the more accurately does he retain what he has learned.

This lesser efficiency of the child's memory so far as the act of learning is concerned explains the difference in the results obtained by different methods of learning. We found, namely, that in the child's mechanical learning, the part-procedure at first leads more rapidly to the goal than the whole-procedure. This is due to the fact that the child finds the whole-procedure displeasing and discouraging at first because he feels that he is making no progress. It is characteristic of the mental operations of children, however, that, especially in younger children, their emotions and their moods are of prime importance in determining the success or failure of their work. Disinclination and faint-heartedness, fear of having been assigned a task which is beyond their powers,—these are usually not overcome in the case of the child, as they are in the case of the adult, by an increased effort. The child is at the mercy of these debilitating moods; again and again we found in our experiments that nothing is so important for the mental work of children as the consciousness that they are able to accomplish the task assigned. When the child learns his material in parts he is aware of his progress from the outset; applying himself to small sections he soon masters them, one after another, and feels that he will soon be master

of the whole situation.[1] This changes, however, as soon as he becomes aware of the advantages of learning the material as a single section. With increasing practice even the child learns more rapidly, with fewer repetitions and with more accurate retention when he employs the whole-procedure. When significant material is learned, the whole-procedure proves to be almost as advantageous for children as for adults, as is shown by the following data: Employing the part-procedure, an eight-year-old boy learned a verse of Goethe's *Erlkönig* in seventeen repetitions; in eleven repetitions when he employed the whole-procedure. He learned another verse of the same poem in fifteen repetitions when it was divided into two sections; and immediately afterwards he learned the next verse as one section in ten repetitions. Approximately this same state of affairs was found with all school-children. Subsequent re-learning was easier when the stanzas had originally been learned by the whole-procedure. This is true also for larger amounts of material so long as they do not fatigue the child. We may therefore regard the following general result as established: For adults and children it is more advantageous and it is psychologically and pedagogically more appropriate to learn every sort of material as a whole than to break it up into parts.

But what is to be said of the learning of material which does not constitute a coherent whole, such as names, dates, the words of a foreign language, etc.? Experiments which have been conducted in my laboratory show that with this sort of material also it is more advantageous to employ the whole-procedure than to learn it in parts. Words of a foreign language,—Italian, Russian, Latin, Bulgarian,—to the num-

[1] For a discussion of these and other inhibitions of the will of the child, see Meumann's *Vorlesungen zur Einführung in die experimentelle Pädagogik*, I., 297ff.

ber of fifty, were read aloud to observers; in one case, the words were learned in the usual manner, each pair being memorized separately; while in another series of experiments the whole series was read through from beginning to end. The latter procedure gave the better results and was in every way more economical.

The reason for this advantage is probably to be found chiefly in the fact that in learning the series as a whole the observer is impelled to distribute his repetitions uniformly and abundantly, and to concentrate his attention equably throughout. Something which is relatively new is presented to the attention at every step; by this means, a non-significant and purely mechanical recitation is avoided, and not a single repetition fails to be productive in the acquisition of the material. On the other hand, of course, there is here no reinforcement of learning by means of a coherence of the whole body of material.

According to investigations made by Neumann, at the instigation of Martius, upon high school pupils from nine and a half to ten and a half years of age, there are certain other points of view which must be taken into consideration in deciding the relative merits of the different methods of learning. This investigator also found that the whole-procedure is much more economical than the part-procedure. But the advantage of the whole-method is immediately apparent only in the case of bright pupils and rapid learners; with dull pupils the advantage appears gradually, and only after long practice. It turns out, too, that increase of practice benefits the whole-procedure more than the part-procedure. Other results of Neumann's experiments will be discussed later; let us here mention only that he found the superiority of the whole-procedure to be evident also in cases where the material is to be reproduced not in its original but in a changed order.

Do these two methods of learning always remain equally advantageous and disadvantageous with every sort of material? This question was investigated by Ephrussi in an extensive series of experiments in G. E. Müller's laboratory at Göttingen. Groups of nonsense-syllables, pairs of Russian-German words, combinations of words and numbers, and stanzas of poetry were learned by each of the methods. Ephrussi found the surprising result that the part-procedure[1] gives better results with nonsense-syllables, while the whole-procedure is more advantageous with significant material. This she explains from the fact that in dealing with nonsense-syllables we are obliged to devote a certain amount of effort to the task of becoming acquainted with the material itself, that is, we must become familiar with the nonsense-syllables whereas we are already familiar with the significant words. And, she adds, the part-procedure familiarizes us with the syllables more rapidly than the whole-procedure because individual repetitions in immediate succession can always make use of the after-effect of the previous reading of the syllables. (Ephrussi refers to this after-effect as a *Perseveration.*) This finding has no essential pedagogical significance because, in the first place, children are not required to learn nonsense material, and hence the whole-procedure is better for all material learned at school. And secondly, Ephrussi did not investigate the general effect upon memory, in particular, she omitted to investigate permanent retention; she determined only the *Treffer*, that is, the reproduction of a syllable from the clue furnished when the experimenter presented the syllable which had been learned with it in a single unit of time or rhythm. From this datum alone it is impossible

[1] Ephrussi calls the part-procedure the method of learning by accumulated repetitions. This is not an appropriate term because the whole-procedure is also a learning by accumulated repetitions.

to draw any reliable conclusion regarding the economy of a method of learning.

However advantageous the whole-procedure may be, it must be adapted and modified before it can be employed in the work of the school-room because a condition which we have assumed throughout the foregoing discussion is seldom fulfilled in the work of the school-room,—namely, one rarely finds that the material to be learned is equally difficult in all of its parts. If a poem or a list of words contains parts which are very much more difficult than any of the other parts, the method which learns it as a whole compels the learner to continue reading the easier parts which have already been mastered, for the sake of the more difficult parts which have not yet been mastered. This is of course a disadvantage; and the method has yet another objection.

It may be shown experimentally that when a large body of material is learned in one piece,—for instance, a poem of eight stanzas or a series of sixteen syllables,—the concentration of attention is not so uniform throughout as one might suppose. The attention rather follows a typical curve of varying degrees of concentration showing a maximum intensity at the beginning and towards the close but relaxing at, or slightly beyond, the middle region. In consequence of this, the middle portion of the material is always learned most slowly when the whole-procedure is employed; and if the learning has not been thorough the middle portion of the material is soon forgotten. This typical behavior of attention can readily be observed in the learning of nonsense-syllables. Ask an observer to learn a series of syllables by the whole-procedure; interrupt him as soon as he has read the list through twice and find out what he has already learned. Then have him read the whole series twice more and again determine how many and which syllables have been learned.

If this experiment is continued until the whole series is committed to memory the records obtained at the various stages during the progress of learning will show the order in which the various members of the series are mastered. It will almost invariably be found that the first syllables and the last syllables are memorized first, that the intermediate syllables are acquired more slowly, and that at a certain point in the series,—about the ninth or tenth syllable,—there lies a minimum degree of concentration, as is shown by the fact that these syllables are almost invariably the last to be learned. If the series is very long, two minima of concentration usually appear. In learning by the part-procedure these minimal degrees of concentration do not make their appearance because with the beginning of each section of the material the attention revives with renewed energy and with a maximum of concentration.

We have attempted to overcome these two objections by introducing procedures which have been called the mediating procedures. These methods occupy a position intermediate between the whole and the part-procedures; and they combine the advantages of both without possessing the disadvantages of either. One of these mediating procedures stands the test with all sorts of memory material. In this procedure, the whole body of material is divided into parts, the basis of division being the degree of difficulty of content; and the parts are marked off by a stroke, or, if convenient, by a blank space. In reading the series the learner pauses for a short time at the end of each section but he does not then return to the beginning of the section; instead he continues to read through to the end as in the case of the whole-procedure. *1.* Hence as in the whole-procedure associations are formed only in the direction in which they are to operate in subsequent reproduction; and retrogressive associations at the end

of the various sections are avoided. 2. The pauses at the end of each section enable the attention to return to its task with fresh vigor and with a maximum degree of concentration. This procedure can best be illustrated from its application to nonsense-syllables; and the principle may then be carried over without change to any other sort of material. A series of twelve syllables is written in two sections of six syllables each, and between the two sections is a blank space. In reading the series the observer always pauses at this point but thence continues to the end, never returning to the first syllable from the sixth.

A second mediating procedure can best be employed with non-coherent material, such as the vocabulary of a foreign language. In this method the reading of the series of words progresses continuously until the learner observes that certain members of the series prove to be especially difficult. These he indicates by a written mark; he devotes a special effort to learning them and then returns to the reading of the whole series,—continuing until the whole is uniformly memorized. This variation of procedure enables us readily to adapt the whole-procedure to material which is not uniformly difficult throughout its length. Numerous experiments have demonstrated the superiority of these methods over the ordinary whole-procedure.

Our experiments have shown that the mediating methods are capable of very wide application, and that they are exceedingly advantageous and economical. It must be noted in this connection, however, that these two are not the only possible modifications and adaptations of the whole-procedure to the nature of the material.

Neumann obtained a somewhat different result in his investigation of the learning of a French vocabulary, where the whole-method again proved to be the more advantageous.

In these experiments Neumann made a special investigation to determine which method of learning a German-foreign vocabulary ensured the most accurate reproduction,—the learner being asked to reproduce the pairs of words in an order which differed from that in which they had stood upon his printed list. Here again the whole-method gave better results, but that was probably due to the form in which the mediating method was employed. Neumann himself advances the hypothesis that there are various possible reasons for this phenomenon; and he is of the opinion "that the form and the content of the material to be learned, and the individuality of the learner must determine which method is best in any given instance."

Now it must be observed that all of the investigations of learning which we have described were concerned exclusively with learning by rote, and with the proper formation of such associations as are necessary for verbal memorization. In the next section we shall deal with special conditions not only of mechanical memorization but also of the learning of significant and intelligible material. It is upon an understanding of these conditions that a real technique of learning must be based.

4. *The Conditions and the Technique of Mechanical Learning*

Every act of learning is, in part, mechanical,—even that learning in which we derive aid from an understanding of the material, or from an apprehension of its logical, ethical and æsthetic meanings. This mechanical aspect of learning consists in a repeated imprinting, during which the will and the attention are not directed toward an understanding of the material, as such, but toward an acquisition and imprinting itself which become the object of our activity while the understanding of the material is subordinated as a means to this end.

The more complete the mastery and the more perfect the command which we wish to obtain over any memory material, or the more easily, certainly and permanently, and the more accurately and completely we wish to be able to reproduce it, the more must we bring into operation this activity of sheer imprinting and its chief means,—the attentive repetition of the material.

Attentive repetition tends more and more to become our sole means of learning in proportion as the material offers few opportunities for a formation of associations, for an incorporation of the material into larger groups of mental content and for a logical and intellectual elaboration of its meaning. Attentive repetition becomes a less and less important factor in proportion as the material affords more of the above opportunities; but it never wholly loses its significance. In learning significant material the adult is often disposed to underestimate the importance of this mechanical factor of attentive repetition in which the imprinting becomes an end in itself, because in the course of his development he has always set out to apprehend the concrete ideational content or the abstract thought-content of all memory material in order to utilize these as means to retention. In so doing he abandons the habitual use of mechanical learning; but in all cases where he must recall any material in accurate verbal form, he finds it impossible to dispense with the use of the mechanical factor of learning. Hence with advance in mental development we tend more and more to abandon the *fac simile* mirroring of our experiences; and in place of *verbatim* reproduction is substituted an independently elaborated and individualized copy of our experience. In making this substitution, however, we no longer reproduce the original experience but only make an approximate copy of it.

Wessely reports that this phenomenon appeared in the

different classes of a high school in Berlin. He wished to determine whether memory material which had been learned in the various departments of the school was still retained in memory after long intervals of time, and whether it promised to become a permanent possesesion of the pupil. Pupils from ten to fifteen years of age were asked to write from memory a poem which they had learned about a year before; and from the data thus collected Wessely determined the amount remembered.[1]

In a second experiment, boys of nine to fifteen years of age were asked to learn lists containing eight Latin words with their German equivalents. The memorial effect of the learning was tested immediately afterwards, and also after intervals of one day, eight days, and four weeks. The procedure employed in testing their reproduction consisted in presenting the German words in a changed order, and having the pupils recall the corresponding Latin word.

These investigations showed that retentive capacity increases, in the first type of experiment, up to twelve years of age, in the Latin vocabulary test, up to eleven years, inclusive; and from there onward retention and certainty of reproduction decrease. These experiments with high school pupils confirm the main results of the investigations of retention which have already been reported; after the pupil reaches a certain age, however, it is found that accuracy of retention decreases with increase of age. The only divergence from our results is Wessely's finding that retention increases up to about the age of twelve years. Wessely himself is not willing to ascribe this increase to an increase of formal training in learn-

[1] R. Wessely, Zur Methode des Auswendiglernens, *Neue Jahrbücher für das klass. Altertum*, 1905, 297ff; 373ff. Certain of Wessely's conclusions with which the present author does not agree are discussed in the latter's *Vorlesungen zur Einführung in die exp. Pädagogik*.

ing, but refers it to the natural growth and development of mental capacity. As a matter of fact, two different phenomena make their appearance in these experiments. The memory of some pupils continues to develop for a time; and children pass over more and more to the memory type of adults, that is, they begin to rely more and more upon apprehending and reproducing by content alone, and abandon the accurate, and especially the verbal, memorization of material.

The mechanical factor of memorization comes into operation in more pure form the more meaningless is the material to be learned; and hence dates and pairs of synonyms are learned more mechanically, that is, more through the influence of mere attentive repetition, than are grammatical rules. We find the purest illustration of the type of mechanical memorization in the learning of meaningless material; in psychological experiments it is illustrated in the memorization of nonsense syllables. Hence the significance of experiments in learning with nonsense syllables consists in the fact that they show us in purest form the conditions of the mechanical factor in learning. The existence of these conditions is here shown either by mere observation of the learner's procedure, or in much more exact form, by systematic variation of particular factors of learning. When one of these factors is varied independently while all of the other factors remain unchanged, we are in general justified in ascribing any variation in result to the influence of this one changed factor; and then we can draw inferences as to the significance of this factor itself. For example, in one case we vary only the tempo of learning, in another case the rhythm, in a third the distribution of repetitions; and we determine how each of these changes affects the result of the learning. The inference that this variation in result is to be ascribed solely to the changed condition is not at once permissable: and it frequently

requires numerous variations of the original experiment to clear up the matter and to bring out the casual relation distinctly.

Investigations of this sort, where the particular conditions of learning have been varied systematically, have given us our chief insight into most of the conditions of mechanical learning. I shall present a survey of these conditions as they have been revealed by the results of experiments heretofore undertaken in this field.

The conditions under which we learn a material are partly determined by external, objective factors, such as the material itself, its amount and its character; they depend, in part, upon the subjective factors which together constitute the learner's procedure. We may accordingly subdivide the conditions of learning into external or objective, and internal or subjective. The subjective conditions again are concerned partly with the general behavior of the learner, his internal condition, his attention and the like; partly with the formation of associations. In all of our subsequent discussions we shall take the experimental learning of nonsense syllables as the typical case of mechanical learning.

Among the external conditions of learning we may mention, first of all, the tempo of learning, or of speaking or reading during the process of learning. This carries us over into the most universal and fundamental condition of memorial work[1] because the tempo of learning determines the time during which not only the single syllable remains in consciousness and is imprinted upon consciousness, but also the rapidity with which the associations between the several syllables are formed. Experiments have shown that the tempo of speech during the process of learning exerts a strong influence upon the rapidity with which we succeed in memorizing. Ebbing-

[1] See pp. 15f.

haus[1] asserts that according to his own observations the most rapid learning is the most advantageous, at least in so far as ratio of amount learned to time expended is concerned. Ogden, however, did not find a confirmation of this statement; his experiments show only that rapid reading secures a better survey over the series of syllables. According to Ogden's results, the number of repetitions increases so rapidly with increased rapidity of learning that rapid learning may become disadvantageous.[2] I have found that neither rapid nor slow learning is in itself advantageous; but that the matter depends chiefly upon adapting the rate of learning or of reading or speaking to the degree of familiarity of the material, to the progress of memorizing and to the individuality of the learner. When we set to work upon an unfamiliar material it is, of course, disadvantageous to sweep over it with the eyes and with the attention in an effort to learn it with extreme rapidity; this procedure decreases the memorial effect of the first repetitions because in such cases we do not become familiar with the material until the third or fourth repetition. We waste repetitions in our attempt to obtain a correct apprehension of the visual-auditory impressions and to understand the meaning of the material. This is true even in the case of meaningless material. In the learning of a meaningful text a too rapid rate of reading prevents our comprehending the meaning, as was shown from observations which I made in Kraemer's[3] experiments. In the case of a significant text it is an indispensable condition of economical learning that the rate of reading should be adapted to the

[1] H. Ebbinghaus, *Psychologie*, Leipzig, 1902, (Dritte Aufl.), I., 672.

[2] *Cf.* the observation by Ephrussi, p. 262 of this volume.

[3] N. Kraemer, *Experimentelle Untersuchungen zur Erkenntnis des Lernprozesses*, Leipzig, 1912. See also Dürr, in Ebbinghaus' *Psychologie*, Dritte Aufl., I., 674.

understanding of the content of the text. When on the other hand, we make our first reading as slowly and as attentively as possible, and then gradually increase the rate of reading and of learning we obtain the best results. I performed the following experiment in the investigation of this problem: The revolving drum which carried bands of nonsense syllables was provided with a crank so that it could be rotated by the learner himself at whatever rate he chose. The rapidity with which he rotated it was recorded accurately, to one-hundredths of a second, by a graphic method. The sole instructions given to the learner were that he should rotate the drum in such manner that he might learn most conveniently and might feel that he was making the most satisfactory progress. Our results show that the drum was rotated very slowly at first, much more slowly than in the ordinary experiments with syllables; then the rate increased with periodic accelerations and retardations until, toward the close of the period of learning, the learner chose an exceedingly rapid rate of reading which permitted only a fugitive and superficial glance. This experiment shows that the rapidity of learning must be adapted to the degree of memorizing which has already been acquired,—the appropriate technique of learning requiring a slow learning at first, followed by a more and more rapid rate. Hence we miss the mark if we constantly force the learner to memorize slowly; as we also do if we urge him constantly to hasten as Ebbinghaus believed that we should do. After memorization has made a certain amount of progress, a slow rate of reading becomes more and more disadvantageous. Not being sufficiently employed, the attention digresses; sensations of strain, impatience and aversion make their appearance, and all of these have an unfavorable influence upon learning.

These experiments were subsequently varied in such fashion

as to allow the learner to choose his own tempo; and here it was found that different learners proceed differently under these conditions. Some, apparently those of especially impulsive nature, begin with an exceedingly rapid tempo; then they slacken their speed and again accelerate it toward the close of the period of learning.

Rapid learning is not advantageous for permanent retention. In general it seems to be true that the more rapidly we learn the less permanently do we retain. This appears to be confirmed by all the later experiments of G. E. Müller's pupils. Thus Ephrussi found the "paradoxical" result that a tempo of reading and learning proves to be economical or non-economical of time according as the retention is tested by the method of re-learning or by the method of paired associates.[1] That is, although we save time by learning rapidly we make fewer "hits," or fewer correct reproductions of the immediately following syllable when any given syllable is named by the experimenter. This can be explained only on the assumption that an acceleration of the rate of learning may be of advantage in securing a first correct memorization, but it is not advantageous for permanent retention. This result of Ephrussi's[2] was tested by Jacobs whose method consisted in an auditory presentation of nonsense syllables.[3] The experimenter read the syllables aloud in trochaic rhythm, from a revolving drum, while the observer listened with closed eyes. Here again, learning was more rapid when presentation was more rapid, that is, the total time required for the memorization of the series was shortened. Unfor-

[1] *Cf.* p. 167.

[2] P. Ephrussi, *Op. cit.*, p. 192. Concerning alleged "economy of energy" see Appendix II.

[3] W. Jacobs, Ueber das Lernen mit äusserer Lokalization, *Zeitschrift f. Psychologie*, XLV., 1907, 43–77; 161–187.

tunately, Ephrussi and Jacobs did not determine the effect of change in rate of learning upon permanence of retention. A survey of all of these experiments gives us the following view concerning the significance of the tempo of learning. A certain optimal rate of learning leads most rapidly to initial memorization; where this is the only aim of learning, therefore, the rapid rate is economical. But the rapidity of the single readings must not be too great; because if it is, the gain in time is more than compensated by an increase in the number of repetitions required and by a corresponding increase of fatigue. The more rapidly the material is learned, the less permanently is it retained; and where permanent retention is desired, rapid learning is uneconomical. Real economy of procedure always consists in adapting the tempo of learning to the individuality of the learner and to the stage which he has momentarily reached in his act of learning.

Another very important external condition of learning has to do with the rhythm which the learner employs. All experimenters testify that it is in the highest degree disadvantageous to learn without rhythm. Experiments by Müller and Schumann, and by M. K. Smith yielded the result that a suppression of rhythmic vocalization makes it almost impossible for certain individuals to learn. In continually repeating a material, we involuntarily fall into a rhythmic speech, and the intentional continuation of this rhythm is advantageous in learning. Of special importance here is a definite grouping of our impressions, that is, a combining of syllables into visual and auditory groups; and experiments have shown that the members of such a rhythmic group enter into a particularly secure association with one another. Now the question arises: Which rhythm or which poetic meter proves to be most favorable for learning? We found that, in general, the dissyllabic

verse-foot is the most favorable. It is, moreover, advantageous to combine the single feet into groups so that, for example, a series of twelve syllables is apprehended as two groups of six syllables each. Some find it more convenient to combine a series of twelve syllables into three groups of four syllables each. G. E. Müller believes that for Germans the trochee is, in general, the optimal rhythm; but we have not found this to be confirmed in our laboratory. In two investigations, where the observers included natives of fourteen different countries, we determined which rhythm was preferred by each observer. We found that rhythms are distributed over the different nationalities in the most irregular fashion; indeed, the preferred rhythm in many countries differs for different provinces. North Germans tend to accentuate the ultimate syllable, South Germans the initial syllable; and each of these habits has an influence upon learning. Nagel found that the North Germans and the Scandinavians learn with a rising inflection, the South Germans with a falling inflection. G. E. Müller has recently emphasized the value of investigating the formation of rhythmic complexes and their influence upon learning. From observations made by Nagel and Meumann the formation of complexes appears to be largely an individual matter, that is, the mode of combining the elements of a nonsense series in learning seems to vary from individual to individual. The significance of these complexes for the economy of learning seems to me to consist in the fact that their existence indicates that the individual learner has discovered the particular rhythmic grouping which is most appropriate for him. Moreover, differences in the learner's procedure and in the effect of learning come into consideration in this manifold variety of possible groupings; and while these differences may be of interest in a highly specialized psychology of memory they have no direct bearing

upon our present discussion whose purpose is of a dominantly practical sort.[1] The further question may be raised: Is it easier to learn by reading aloud, in an undertone, or silently? We found that *sotto voce* learning gives in general the best result. An exception to this, however, is furnished by young children, where one finds, remarkably enough, that silent reading is most favorable to learning. But this again probably varies with the ideational type of the individual; the more the learner employs motor imagery, the more advantageous is his motor speech. *Sotto voce* speech seems to be most advantageous for the auditory-motor type; reading aloud distracts their attention too much.

Another group of external conditions of learning includes the manner in which we imprint the material by repetitions. In connection with the repeated reading of materials a first question to arise is: Is it advantageous to learn the whole material at a single sitting? Or do we gain anything by interrupting the readings and distributing them over a number of sittings? Ebbinghaus found that the distribution of repetitions in learning is an especially important condition for the economy of energy. He discovered, namely, that in series of syllables where we do not accumulate the repetitions but distribute them over a long period of time with intermediate pauses we find that a great saving of repetitions results. For example, when the repetitions were distributed over three days, each series required thirty-eight repetitions, while sixty-eight repetitions were necessary when they were all accumulated at a single sitting. This problem was investigated more accurately by Jost;[2] we shall select one of his experiments

[1] The reader is referred to my criticism of G. E. Müller in Appendix II.

[2] A. Jost, Die Associationsfestigkeit in ihrer Abhängigkeit von der Verteilung der Wiederholungen, *Zeitschr. f. Psychologie*, XIV., 1897, 436–472.

to illustrate his plan and method. In one case, he devoted thirty repetitions without pause to the learning of a series of syllables; in another case, he employed ten repetitions on each of three successive days. In both cases he tested accuracy of retention twenty-four hours after the repetitions had been completed. He found that the syllables which had been learned with distributed repetitions were retained better than those which had been learned with the same number of accumulated repetitions. Jost also attempted to determine how far the distribution of repetitions may be carried without giving rise to a deleterious result. He found that when the material to be learned is of large mass the most extensive distribution is the most advantageous, both as to rapidity of learning and permanence of retention. Even when the distribution is spread out to such an extent as to make but a single repetition per day, the result is better than when the repetitions are accumulated into a single sitting, provided, of course, that other circumstances do not make such an extensive distribution disadvantageous. Jost attempts to explain this striking phenomenon from his "law of the age of associations." "Older" series of associations, *i.e.*, those series of associations which were acquired some time previously, are, according to this law, more readily refreshed and reinforced than "younger" or more recently acquired associations, or as Jost expresses it: "Of two associations which are of equal strength but of different ages, the older receives the greater intensification from a new repetition." Now when the repetitions employed in learning a material are spread out over a longer period of time, it comes about that we deal more and more with relatively old associations, while when the repetitions are accumulated we are forced to work with relatively young associations. Jost's law does not seem to be valid for smaller and easier materials, where we find that uninter-

rupted learning until memorization is reached proves to be more advantageous. We need scarcely do more than indicate the pedagogical significance of Jost's law. Whenever the child is obliged to master a voluminous memorial material he should be given instruction and opportunity to learn it in easy stages; the memorization should not be forced but the repetitions should be distributed as widely as the prescribed course of teaching permits.

We have repeated Jost's experiments, and on the whole we have confirmed his findings. One of our observers was exceptional, however, in that the distribution which prescribed one repetition per day proved to be disadvantageous on account of his forgetting between sittings.

This problem is to be carefully distinguished from another of kindred nature. Apart from the question of temporal distribution we may ask what significance the number of repetitions has for learning, and especially for retention. Or what is the effect of an accumulation of repetitions of any given material? Let us assume that a material which, so far as its amount is concerned, can be learned perfectly well at a single sitting is learned until it can be repeated once from memory. What now is the effect of additional repetitions? Of course one would expect that the material would become more firmly fixed in memory and would be better retained. But the question arises: *1.* Is this expectation fulfilled? *2.* Is this increased retention relatively easily attained, or only by a great number of extra repetitions? According to the experiments of Ebbinghaus the extra repetitions gradually become less and less effective so that, for instance, a disproportionately large number of repetitions must be employed in order not only to attain the first recitation from memory, but to imprint the material so indelibly upon memory that it can be repeated without error at the end of twenty-

four hours, or can be retained permanently. This observation was, in general, confirmed by Weber and by Knors; but these investigators also show that a process of learning which has been continued only to the point where a first recitation from memory is just barely possible does not by any means guarantee a complete mastery or a permanent retention. Many additional repetitions are still necessary before a lasting retention is attained. It is clearly evident that immediate reproduction is a potent factor even in this process of "first correct recitation."[1]

Certain important rules for the practice of teaching may be derived from the foregoing. *1.* The mere act of learning a material until it can barely be reproduced never secures a permanent retention in the case of nonsense material of considerable bulk, even up to ten or twelve syllables; in the case of significant material it very seldom secures a permanent retention. From this it follows: *2.* that for everything which is to be retained permanently, a subsequent "freshening" by means of additional repetitions is indispensable. It follows, too, *3.* that we should not be content to regard the ability barely to recite it from memory as an indication that a material has been memorized. Really permanent retention or complete mastery demands many more repetitions for its achievement. We see here how important the factor of mechanical learning is for genuine memorial function. That which is to become an imperishable possession of memory,—not as a part of one's systematized body of knowledge, but only as a datum of concrete cognition,—can be acquired only at the cost of many repetitions. *4.* If we wish, at a single sitting, to learn a

[1] J. Weber, Untersuchungen zur Psychologie des Gedächtnisses, *Zeitschrift f. d. exper. Pädagogik*, VIII., 1908. C. Knors, Experimentelle Untersuchungen über den Lernprozess, *Archiv. f. d. gesamte Psychologie*, XVII., 1910, 297–361.

material so perfectly that it will be retained permanently we must devote an excessive number of repetitions to it; and even then the result, so far as permanent retention is concerned, will remain in doubt.

Among the external conditions of memory must also be mentioned the mode of presenting the material. It is a matter of importance whether the learner himself reads the material or whether he hears it read. Thus we distinguish between learning by means of visual and by means of auditory presentation. It is of especial interest to pedagogy to determine whether either of these is a more profitable procedure than the other.

We have investigated this problem experimentally, and we found that learning by means of the visual method is easier, both for children and adults, than by the auditory method. This is true both for meaningless and meaningful materials. This law is limited in its application, however, on account of the dependence of learning upon the individual equipment of the learner, and particularly upon the ideational type to which he belongs. It is to be expected that a person whose imagery is essentially visual will learn better from visual presentation, while the representative of the auditory type will learn more readily that which he hears. But still we have found that even the auditory individual sometimes learns better from visual than from auditory presentation. This I find to be true of myself. It is due in part to habituation, and in part to the fact that more associated elements come into play in visual presentation. Our observations must be supplemented, first of all, by the results obtained by Pohlmann, who reports that nonsense material is learned better from visual presentation, while significant material is learned better when heard. But this conclusion is unfortunately invalidated by the fact that Pohlmann did not take the ideational

types of his observers sufficiently into account. Then, too, it seems natural to suppose that the advantages possessed by visual presentation, in the case of nonsense syllables, may be due merely to the fact that visual stimuli are apprehended more readily than auditory stimuli. If this is true, the phenomenon does not belong to the domain of memory or learning at all and would not occur with materials which are more easily perceived and apprehended.

This phenomenon, however, has no direct bearing upon the work of the teacher. One may not infer directly from this that in the school-room it would be more advantageous to have the pupils employ visual learning exclusively because there are many secondary circumstances which would invalidate the rule. Among these is the circumstance that auditory learning, or the act of learning from the oral instruction of the teacher possesses more of the character of common and equal work by every member of the class, while in visual reading each pupil is left more to himself. The former is always a more favorable condition for the work of children.[1] Moreover, auditory learning provides an incentive to the attention of children; and in using this method of presentation the teacher can more readily influence the will and secure the active co-operation of his pupils. These secondary effects of teaching are probably more significant in auditory than in visual learning. If some investigator would clear up this matter by experimentation he would render a distinct service to psychology.

It may be assumed to be very probable that certain factors

[1] *Cf.* Pohlmann, *Op. cit.*, pp. 168ff.; also Pentschew, Ueber Oekonomie und Technik des Lernens, *Arch. f. d. gesamte Psychologie*, I., 1903, 514. For a discussion of the influence of the class upon the work of the individual pupil, see the papers by A. Meyer, F. Schmidt, and W. Baade.

which appear to be subordinate still serve as aids to memory in the act of learning. To this group belongs the localization of the items in the material which is learned. We know that certain individuals tend to note the position upon a page where a passage stands. When the child learns words or dates he may imprint a visual picture of the page or column where they occur. I know a man who memorizes his lectures so perfectly from his manuscript that in lecturing he is able to follow the original, page for page, in a purely mental fashion. This factor of localization is an important aid to memory. Its significance for the learner is intimately related with his memory type. The visualizer employs spatial localization much more than do individuals who belong to the auditory and the auditory-motor types; he establishes definite associations between certain items of the memorized material and their position upon the page, and he also associates them with other visual criteria especially those of a spatial sort. Müller and Schumann found that in learning nonsense syllables we note the "absolute position" of particular syllables, and that this process is an aid to retention. Müller and Pilzecker discovered still other sorts of localization which probably have greater significance for the auditory-motor learner. The position of an item in a memorized group of syllables or words may be remembered in three different ways: *1.* Localization in visual space. This consists in associating the syllable, word, or group of words with the position where it was seen. *2.* Localization by means of verbal labelling. The syllables are counted during the process of reading, and the number or numerical position of particular syllables in the series is noted and remembered. *3.* Localization by means of modulation of speech. The observer remembers the variation of inflection or of melody of speech with which the material was heard during the process of learning. This third sort of

localization is successfully employed only by individuals of the auditory type.

Walther Jacobs made a detailed investigation of the influence of external and internal localizations. Syllables were learned by auditory presentation, the observer having before him cards upon which were printed as many circles as there were syllables in each series. In a first group of experiments, the observer looked at these circles while the syllables were being read to him, and imagined each syllable to be localized in one of the circles. In a second group of experiments, the observer listened with closed eyes and attempted to localize the syllables in a purely subjective fashion. Jacob's results showed that observers differ very greatly in procedure according to their ideational type. Visualizers transform the auditory syllables into visual images, sometimes so definitely and clearly that they are able to describe even the handwriting into which they have transformed them; they also localize and "mark" the position of syllables in a perfectly definite manner. The presence of the schema of circles facilitated localization for all learners; but visual learners localize more definitely when their eyes are closed than when they see the circles. Auditory and auditory-motor learners localize much less definitely; and with closed eyes their localizations are exceedingly imperfect. A characteristic feature of these results consisted in the fact that an increase in the rapidity of reading forces the learner to make more and more use of his auditory imagery; and this is true even of the visual type of learner. This finding confirms my own view that visual ideating is always a slower process than auditory-motor ideating. On the whole, the introspections of observers indicate that a rapid tempo of presentation increases the rapidity of auditory-motor learning; and in the case of the auditory-motor type, the more rapid tempos are advantageous for this

form of learning. A slow tempo possesses corresponding advantages for visual learning.[1]

It is worthy of note that the visualizer probably makes greater use than do the other types not only of visual criteria but also of criteria derived from spatial localization in general.

Among the external circumstances which have a direct bearing upon learning must be mentioned yet another difference in the learner's mode of procedure; and this may be designated briefly by the phrases "learning by means of purely visual reading" and "learning by hearing oneself read." Whenever an adult learns any material by reading it over and over again, it may always be observed that only during the first few readings is his attitude and behavior similar to that of an ordinary reader; so soon as he begins to become familiar with the material he takes up the attitude of an auditor and listens to his own reading. He attempts to recite the material from memory, and he glances back to the text again only when his recitation hesitates or halts. Witasek showed by a special investigation that these two modes of procedure have wholly different effects upon learning.[2] Recitation is considerably more effective in securing a first perfect memorization than is simple reading,—perhaps as a result of the greater amount of energy expended,—and the effect is greater when a certain amount of memorization has already taken place in consequence of previous reading before recitation is attempted. Katzaroff also found, on repeating Witasek's experiments, that when recitation is combined with reading in the act of

[1] *Cf.* Müller and Pilzecker, *Op. cit.*, p. 221; R. M. Ogden, *Archiv f. d. gesamte Psychologie*, II., 1903, 120; A. Pohlmann, *Op. cit.*, 29; W. Jacobs, *Zeitschrift f. Psychologie*, XLV., 1097, especially 44.

[2] S. Witasek, Ueber Lesen und Rezitieren in ihren Beziehungen zum Gedächtnis. *Zeitschrift f. Psychologie*, XLIV, 1907, 161ff.; D. Katzaroff, Le rôle de la récitation comme facteur de la mémorisation. *Archives de psychologie*, VII., 1908, 225–258.

learning a more permanent retention results. It is expedient, therefore, to employ a combined procedure,—combining a number of readings of the material with a number of attempted recitations, and prompting the learner meanwhile whenever he hesitates. Witasek experimented with twelve combinations of the two factors which may be presented in tabular form,—the number of readings being indicated by Roman numerals, and the number of recitations by Arabic:

VI...0	VI...5	VI...10	VI...15
XI...0	XI...5	XI...10	XI...15
XVI...0	XVI...5	XVI...10	
XXI...0			

Of these twelve possibilities Witasek found that a combination of six readings with fifteen recitations is the most economical method so far as saving of time is concerned.

It is indispensable that these experiments be repeated and that their results be confirmed before they are applied in pedagogy because the learning of children is distinguished from that of adults by the very fact that the former learn almost exclusively by a process of reading. Is recitation as effective in the case of children as it is in adults? Does the same combination of readings and recitations give optimal results in the two cases?

A final external condition of learning is a product of the quantity and the quality of the material which is to be learned. As regards its quality, much depends upon whether it is meaningless or significant material; and in case it is significant material, upon whether it is prose or poetry, concrete or abstract, narration or description, and the like. Since we are considering mechanical learning separately, we shall now discuss the influence of amount of material in the learning of nonsense syllables. It may be remarked here that the rela-

tionship between amount of material and act of learning is similar in the case of meaningless and significant materials.

The fundamental question here is: Does difficulty of learning increase proportionately with increase in amount of material? Or does some other relation obtain between these two variables? Ebbinghaus formulated the law that difficulty of memorization does not increase in direct proportion with increase in amount of material, but that larger groups or greater masses of material require a disproportionately greater number of repetitions.

I have repeatedly tested the validity of this law, and I find that it does not hold. More recent experiments conducted by Weber and Knors in my laboratory at Münster revealed the reason for the discrepancy between my earlier results and those of Ebbinghaus. Weber discovered that the law of Ebbinghaus is valid only for unpractised learners. The more training one has in memorization, the more does the number of repetitions show the very opposite relation; that is, the learning of large masses of material demands relatively fewer repetitions than the learning of smaller masses of material. This may be illustrated by citations from our data. Ebbinghaus found that for the learning of groups containing 7, 12, 16, 24 and 36 syllables he required the following number of repetitions respectively: 1, 16.6, 30, 44, 65. Thus the number of repetitions increases much more rapidly than the number of syllables. I have never obtained such results from practised observers; and only with observers who were wholly unpractised in the memorizing of nonsense syllables did Weber and Knors obtain such a progressive increase in number of repetitions. From this it follows that the law of Ebbinghaus does not possess universal validity. Our pupils are on the whole relatively practised learners; and with practised learners we always found a confirmation of the law

which I formulated, and which may be illustrated by the following data:

8	syllables were learned with	5.2 repetitions
12	" " " "	10.4 "
16	" " " "	17 "
18	" " " "	21.5 "
24	" " " "	30 "
36	" " " "	32.5 "

In the data reported by Ebbinghaus the leap from 7 to 12 syllables (1 to 16.6 repetitions) is the only one which is (approximately) valid. This may be explained from the fact that at this point occurs the transition from immediate retention to actual learning. And this relation conforms with our observations of mental work in general, and with all of the findings which have been reported during many years of experimental investigation of memory. It would indeed be remarkable if an increase in the amount of material to which we apply our mental energies did not derive some advantage from the general expenditure of energy and the general adjustment of activity which we must devote to the material when the increment is not present. In the affairs of every-day life a slight amount added to a task does not seem to demand so great an expenditure of energy for its accomplishment as it would if the increment constituted our sole task. So too in the process of learning, our adaptation of attention, our adjustment to the activity and to the material, our mastery of initial disinclination, our steady increase of concentration, our reciprocal reinforcement of associations, and the whole group of constellation factors contribute to the benefit of the material to be learned, if we only bring them into action in the right manner. Or in other words, the amount of material to be learned is not so effective in

determining how many repetitions must be employed as is the coming into play of all of those formal conditions of learning.

At the same time, the slow increase in number of repetitions with increase in amount of material reveals the presence of a fact of will, and also perhaps of an attitude or adjustment, which may be described by the statement that the expenditure of energy is regulated automatically to conform with the magnitude of the achievement which is demanded of the learner. It is a matter of every-day observation that our task progresses more readily when we make it a part of a larger task than when we set about it independently. Our awareness of the fact that the task is larger leads us unconsciously and involuntarily to a keener and more effective concentration of our energies. I have found this phenomenon to occur in learning, in the work-curve, and even in ergographic experiments, so that I am led to suppose that it may be a universal law of will.[1]

Fortunately mind is not organized so uneconomically that, as one might infer from the law of Ebbinghaus, our mental work increases more rapidly than the results which it accomplishes; but, on the contrary, we find a relative decrease in expenditure of energy with increase of mental achievement. This principle holds of course only within the limits of the individual's working-power or his available psychophysical energy. In an investigation of the learning of 20, 24 and 30 syllables,—with myself as observer and Radossawljewitsch and Dannenbaum as controls,—dullness and weariness occasionally made themselves felt in the longest series, and I was then obliged to report that I could no longer succeed in learning; but until one approaches the limit beyond which additional repetitions make no additional contribution to memorial

[1] *Cf.* E. Meumann. *Hausarbeit und Schularbeit*, Leipzig, 1904.

effect, the number of repetitions wholly fails to increase in accordance with the Ebbinghaus law of progression.

These facts have of course an important bearing upon pedagogy. They show us that it is not desirable to reduce to a minimum the amount which is to be learned at a single sitting, as one must infer from the law of Ebbinghaus, but that the task assigned for a single period must be as great as the capacity of the learner permits.

A natural transition to the internal conditions of learning may be made through a consideration of the question: What relation obtains between number of repetitions and concentration of attention? Most psychologists support the view that these two factors are interchangeable with each other. They believe that when the learner concentrates his attention more intensively and more uniformly, he learns with a lesser number of repetitions; and when the learner's concentration is neither intensive nor uniform he must make good this defect by an increase in the number of his repetitions if he is to obtain an equal result from his learning. This law is valid in a certain sense; but its range of validity is limited by the fact that both attention and repetition have their own peculiar effects upon memory. Increased concentration of attention secures one result more rapidly,—namely, a first errorless recitation; but while a saving in repetitions is thus effected, retention is less permanent. Increase in number of repetitions on the other hand, has an especially favorable effect upon lasting retention. This conclusion is supported by various experiments upon memory. We shall return to it in our discussion of attention and forgetting. Let us now turn to the internal or subjective conditions of learning.

It is, of course, very important to know and to control these subjective conditions,—the whole mental disposition which the learner finds to be present during his process of learning.

And it would be an ideal state of affairs if throughout our experiments and throughout the work of the school-room we could keep these subjective conditions as constant and as uniform from day to day as we are able to do in the case of the objective conditions of our experiments. But this is an exceedingly difficult task. It usually lies within the power of the experimenter and of the teacher to choose approximately uniform external conditions under which a child shall learn; but we are seldom able to secure complete control of the learner's internal condition.

A first point which concerns us in learning is the regulation of the attention. The attributes of attention which have chiefly to do with learning and retention are intensity and uniformity of concentration throughout the whole act of learning, and particularly persistence of attention throughout. Every-day experience teaches us that these three attributes have an intimate bearing upon the act of learning. The more intensively a person concentrates his attention upon his act of learning, the sooner will he succeed, as a rule, in memorizing. On the other hand, the attribute of uniformity of attention is concerned chiefly in the learning of a large body of material, and in associating its various parts with a uniform degree of stability. We may distinguish between an individual and a general unevenness or lack of uniformity of attention. General lack of uniformity is due to the nature of the attentive process itself, to the material upon which attention is concentrated, and in part, to the method of learning. We know from general observation that the duration or persistence of attentive concentration varies from individual to individual. There are individuals whose attention functions in a typically regular and uniform fashion; others however possess a typically fluctuating attention which alternates between states of concentration and relaxation.

General concentration depends upon the nature of the attentive process. The nature of attention is such that it cannot function uniformly, and psychology recognizes the existence of normal fluctuations of attention. These fluctuations, whose alternations may be of long or of short duration, make themselves felt, of course, in our learning.[1]

Then too an irregularity in the distribution of attention is due to the nature of the material. When material interests us or when it has meaning for us it claims the attention in greater or lesser degree. Irregularity of attention is even more intimately related to the method of learning which we adopt. It may be said that each method has its own typical distribution of attention, or more accurately, its typical irregularity of distribution of attention. We have already seen that when we learn by means of the whole-procedure we find a typical irregularity of attention to manifest itself in the fact that the middle region of the series of syllables is invariably learned with a lesser intensity of concentration. At the beginning of the series attention enters upon its task with a relatively high degree of intensity, and toward the close a second impulsion of attention makes itself felt; but at the middle region a lesser degree of concentration occurs. When the part-procedure is employed a different distribution of attention takes place. Here it strikes out anew with each new section of the material; but it also dies down more rapidly because when this method is employed the same short section is repeated over and over again in immediate succession. This is the reason why the mediating methods are much more effective for learning. The latter methods provide for the associations being established in proper serial

[1] The physiological causes of fluctuation of attention are discussed by Zoneff and Meumann, Ueber den Ausdruck der Gemütsbewegungen in Atem und Puls, *Philos. Studien*, XVIII., 1901, 44ff.

order; and they also make it possible for attention to recover for a moment at the stopping-places within the group of material, and then to proceed with renewed energy at the beginning of the next section without being dulled or blunted as it advances through the series.

The endurance or persistence of attention must be regarded as another subjective condition of learning. The opposite condition shows itself in the exhaustion of attention. Kraepelin was the first to point out that individuals differ widely in this regard, some possessing an attention which is readily fatigued while the attention of others is characterized by endurance. One need scarcely remark that it is a matter of great importance for the teacher to be able to determine whether a child possesses an enduring or an easily exhausted attention. This factor must be taken into account not only in the management but also in the evaluation of pupils.

Adaptation is another subjective condition of learning which may be explained from the attributes of attention. By adaptation we understand the accommodation of attention to the activity of the moment. We have already seen that individuals differ widely in their rapidity of adaptation. Certain persons are typically rapid, and others are typically slow to adapt; and to this variation is chiefly due the difference between the rapid and the slow learner.

Another subjective condition of learning, and one which has been too little heeded, is the affective state which is present during the act of learning. The emotional condition in which we find ourselves during the performance of a mental task is of profound importance for the accomplishment of the task. In general, it may be said that an emotion of pleasantness facilitates the function of memory, and that unpleasantness has a very detrimental effect upon memory. We are all familiar with the experience that when during a state of

extreme unpleasantness we have to learn something, it usually requires a great effort to overcome the unpleasantness; while a moderate cheerfulness or a calm but pleasurable mood is favorable to efficiency in all mental work. This rule however, is not universally valid. All emotions exert an influence upon the work of memory; and all impair it if they exceed a moderate degree. Experiments have shown that a certain equable mood is especially advantageous for learning. What this statement means can best be described by comparing an unpractised with a thoroughly practised learner. The unpractised learner is usually subject, at the outset, to well-marked fluctuations of emotion. He may feel a certain pleasure in the experiment, perhaps however an uneasiness due to the unfamiliarity of the material and to other external circumstances. This fluctuation of emotion is particularly deleterious to the act of learning. With progressive practice the learner gradually discovers the mood which is propitious to the work in hand; and it seems probable that this is intimately related to the relative degree of intensity with which the desire to learn must be present. If this relative degree of desire is present, the most favorable condition for learning, or otherwise expressed, the state of equable emotion or of emotional equilibrium is attained.

Another group of subjective conditions of learning may be designated by the word "tension." The advent of tensions in the muscular system is a concomitant of concentrated attention. Almost everybody who strains his attention to keen concentration may note that he also contracts muscles at different parts of his body; and these contractions come to consciousness as sensations of strain. The distribution of muscular contractions and sensations of tension is wholly different in different individuals, and is to a certain extent a matter of habit. Certain persons observe them in the mus-

cular apparatus of the sense-organs, especially in the eyes and the visual muscles; others in the toes or in the muscles of the legs; in certain instances, the muscles of the neck are contracted, the teeth are set and the fists are clenched during keen concentration. Now these tensions always make their appearance when we are engaged in learning, and they accompany our every act of learning. How important they are may be seen when we compare the unpractised and the practised observer in a memory experiment. The untrained learner ordinarily employs too much motor strain at first. Such an excessive expenditure of tension impairs the function of memory; and, in consequence, the beginner is obliged to expend many more repetitions in learning a material than the trained observer. During the course of the experiment, however, a feeling of the proper amount of tension is usually acquired by the learner; and then ensues that equable condition which is most favorable for memorial efficiency.

It seems probable that the phenomenon of impulse of will, which Kraepelin investigated, is related with these tensions. We spur and impel the will from within whenever during the course of a long act of learning we detect that the attention is flagging or that the desired memorial result is not being attained. These impulsions probably have both an intellectual and a motor aspect. The intellectual aspect consists in the accomplishment of our task and the realization of the voluntary resolve by whose aid we hold ourselves to the task. The motor aspect consists in the arousing of tensions from the groups of voluntary muscles; and this dual phenomenon brings it about that transient relaxations of attention are eliminated.

A further feature which belongs to the subjective conditions of learning has to do with the disposition of the learner. This simply means our general physical and mental condition.

When the disposition is favorable, the work of memory progresses more efficiently than when an unfavorable disposition is present. A general rule of method may be derived from this because, since investigation shows us that the learner's psychophysical disposition exerts a very strong influence upon the process of learning, the teacher must take this fact into consideration. It is impossible to obtain as satisfactory results from an ill-disposed child as from the same child when in a normal condition. Moreover, it is to be noticed that certain children have abnormally great fluctuations of disposition; these demand a different treatment in a case of long-continued memory work than children who are perfectly sound and normal.[1]

Yet another group of internal conditions is designated by the term practice. This term has a two-fold meaning in the German language. We use it to designate the process of training, and also to designate the result of training. It would be better to substitute for the latter some other term, such as skill. The amount of practice or skill which an observer possesses exerts an exceedingly great influence upon the result which is attained in his memory experiments and in his learning in general. For this reason the experimenter arranges that a so-called maximum degree of practice shall be attained by his learners in the preliminary stage of his investigation. Maximum practice represents the point beyond which further progress is not, or is scarcely, attainable. The practised learner proceeds more economically under all conditions of learning than the unpractised observer. As we have already seen, the former employs no superfluous tensions; he has a more equable mood, more intensive and more regular concentration, requires fewer repetitions, etc. Now experimental

[1] A. Fuchs, *Dispositionsschwankungen bei normalen und schwachsinnigen Kindern*, Gütersloh, 1904.

investigations have yielded the exceedingly important result that learning is to an extraordinary degree subject to training. This phenomenon however is so significant that we shall devote a special discussion to it.[1]

Habituation, as a condition of learning, is intimately related to practice. Habituation also consists of a group of subjective conditions which must be taken into account in the investigation of memory. Every observer passes through a stage in which he is not habituated to memory experiments, not only as regards the objective conditions under which they are conducted but also with respect to subjective procedure, to material to be learned, and to the peculiar demands which are made upon him during the experiment. So long as this period of strangeness and unfamiliarity continues, experiments cannot be conducted properly; hence it is customary to introduce a number of preliminary experiments. The emotional state and the tensions which we have already mentioned belong among the factors of habituation; but neither of them is wholly dependent upon habituation.

Another group of subjective conditions may be referred to as the influence exerted by the ideational type upon the act of learning. The ideational type to which an individual belongs exerts an influence upon the result of his mental work. Thus, for instance, in the experiments which we ordinarily regard as fundamental to the whole psychology of memory,—in the learning of nonsense syllables,—auditory-motor ideation is, on the whole, the most advantageous endowment; and, indeed, an especially favorable condition is found to be present when the auditory-motor type is to some extent combined with the visual type. This is due to the fact that nonsense syllables may be memorized by reading and pronouncing them *sotto voce*. Here we have, on the one hand, a func-

[1] See the concluding section of this book.

tioning of the motor processes of speech with the concomitant sensations of movement, as well as a functioning of the auditory and the visual images of the syllables. On the other hand, the purely visual type is at a disadvantage in this sort of learning because the syllables are seen for but an instant, and moreover the visualizer possesses no vocalization or auditory imagery to reinforce his memory. One finds a similar state of affairs in a great part of the work of the school-room. Children are required to remember a great many things which they learn through hearing alone; and here again the auditory-motor type excels. Hence the ideational type must be taken into account, above all else, in deciding upon the method of presenting material which is to be learned because when the mode of presentation conforms with the learner's type he learns more readily. Jacobs found that when material is presented in auditory fashion the visual observer transforms it into visual images wherever the experimental conditions give occasion for his doing so; and this visual transformation is done with such definiteness by certain observers that they see the letters before them in a particular form of handwriting. Jacobs[1] also reports,—and this is confirmed by every-day observation,—that the visualizer receives more aid from spatial localizations; he notes the "absolute position" of syllables in the series, of words in the list, of sentences upon the page, etc. The auditory-motor individual, on the other hand, notes the position of particular items by labelling them with their consecutive numbers, by observing their position in the "speech melody," and in the vocal rhythms. Most learners seem then to localize the various parts of their memory material but they do so by wholly different means according to the ideational type to which they belong. Consequently Müller and Pilzecker distinguish three sorts of localizations:

[1] W. Jacobs. *Op. cit.*, 50ff.

Localizations in visual space; auditory-motor enumerations; and vocal modulations.[1]

A final subjective condition has to do with the influence of the task or of the will upon the act of learning. Whenever we set to work upon memory material, a definite task or problem hovers before our minds; for instance, we are conscious of the fact that we are to learn a certain number of syllables or verses of poetry as rapidly as possible, in such fashion as to be able to recite them from memory and to remember them as long as possible. The manner in which we ideate the problem or task is a matter of great importance in learning. It may even be shown that the efficiency of the learning is determined by the sort of problem which we set up before ourselves. For example, in experiments upon memory it is necessary that the observer should know during the act of learning whether he is subsequently to be tested by the method of re-learning or by the method of paired associates; and if our experimental procedure includes both methods, we very soon find that the observer inquires: Which method are you going to employ in testing this memorization? When this question is answered he regulates his whole procedure in accordance with the form of test which is subsequently to be applied. If he knows that the method of paired associates is going to be employed, he involuntarily adopts a procedure which makes the association between each pair of syllables as closely knit as possible, and prepares himself relatively little for a free recitation of the whole series of syllables. When, however, he knows in advance that he is going to be tested by the saving method he pays almost no heed at all to the individual associations but devotes himself to learning to recite the whole list. Yet another illustration: When the observer knows that the only thing which is to be determined

[1] *Cf.* the discussion in the foregoing pages.

is the rapidity with which he can learn to recite the whole list once from memory, he adopts a wholly different procedure from that which he follows when he knows that his permanent retention also will be tested. In the former case, he learns only for the momentary effect; in the latter case, he aims to have his learning result in a lasting retention. And if we should deliberately assign the task of learning only for a single recitation from memory but should subsequently test his permanent retention, we would find that he actually retains the material much less permanently. In general, then, we may formulate the rule that the consciousness of the task should correspond as closely as possible with the nature of the achievement which we shall subsequently demand; if the assigned problem does not conform to the achievement which we test, the efficiency of the learning will invariably be impaired.

Everything which we have discussed from the point of view of the conditions of mechanical learning may also be regarded as having to do with the general conditions of all learning because all learning has a mechanical aspect. When significant material is learned, however, a number of additional factors come into operation. The importance of the mechanical factor of repetition is somewhat lessened in logical memorization; but none of the conditions of learning which have been mentioned lose their importance even in the learning of significant material. In discussing these conditions, therefore, we have discussed universal conditions of all learning.

At this point we may present a summarized statement concerning technically correct and economical learning. We learn most economically, so far as time and energy are concerned, when we are familiar with all of the foregoing subjective and objective conditions of learning; when we control these conditions in ourselves, and when, if it is possible to vary the conditions, we adapt them to the purpose for which

the act of learning has been undertaken. That individual possesses a technique of learning who understands these conditions, controls them in his own learning, and is able to adapt them to the purpose for which he learns.

We shall now complete our description of the conditions of learning by adding a discussion of the learning of significant material; here the mechanical factor of attentively repeating the words recedes into the back-ground, and the factor of content or meaning comes into prominence.

CHAPTER VII

ASSOCIATIVE LEARNING (*Continued*)

5. *The Learning of Significant Materials*

It is universally recognized that the learning of significant material progresses more easily, leads sooner to memorization, and results in a more permanent retention than the mechanical learning of unrelated data, such as isolated letters, numbers or names, nonsense-syllables, and the like. Quite as wide-spread, however, as this belief are certain fundamental errors concerning the relation of meaningful or "rational" memorization to mechanical memorization. Investigations in this field of psychological pedagogy have paid but little heed as yet to that type of memorization which is assisted or reinforced by meaning. This dearth of experimentation is easily explained if we but bear in mind the extraordinary variety of possibilities which must be taken into account by the investigator in this field of research; the work of Ebert and Meumann and the more recent work of Kraemer, however, have thrown a certain amount of light upon the learning of logically coherent material. In the domain of significant learning we find that not only do all of the conditions of mechanical memorization co-operate but that the act of learning is now further complicated by the manifold variety of possibilities which arise as a result of the nature of the material to be learned, and of its action upon the learner himself. In significant learning, the quality and the quantity of the material must again be taken into account. As regards quantity, the rules which we have laid down in connection with nonsense-syllables are also valid here, that is, the practised learner also

learns significant material with relatively few repetitions even when the material is of large bulk, and the unpractised learner requires an excessive number of repetitions for the learning of significant as well as of non-significant material.

If we next consider the influence exerted by the quality of the significant material, we again find that it is a matter of importance whether the material is made up of relatively incoherent elements as synonyms, or dates, or whether it forms a significantly coherent whole. In the latter case, again, conditions differ according as we deal with prose, or with poetry where rhythm and rhyme have a facilitating effect. In relation not only to the age but also to the individuality of the learner, much depends upon whether the material is of relatively abstract character,—here the apprehension of logical coherence plays a leading rôle,—whether it is concrete and descriptive or whether it is historical and narrative.

The nature of the material exerts an influence upon learning in the following manner: It is very much easier to remember a coherent body of material than to remember a group of incoherent data. For the latter sort of material the limit of retention in our most highly practised learners was found to be not more than thirteen letters, thirteen numbers, seven to nine nonsense-syllables, ten isolated words, twenty words of a poem, twenty-four words of (philosophical) prose.[1] This brings to light the important fact that learning is not a mere matter of the number of elements but of the number of independent memorial units. For example, our ten words contained about fifty or sixty letters; they were not remembered as so many letters, however, but only in virtue of their memory value as word-units. Here is expressed the universal nature of memory: The only things which we remember are

[1] Ebert und Meumann, *Uebungsphänomene im Bereiche des Gedächtnisses.*

wholes; and particular things are remembered only as parts of unitary wholes. An observer once reported that he remembered a series of syllables by making them into an auditory whole, "a sort of melody." Memory is a synthetising activity which combines elements to form wholes; and data are "associated" when they become parts of a whole for consciousness.

The nature of the content which is to be learned must also be taken into consideration. The content may be relatively concrete or relatively abstract in character; and in the former case it may deal with a concrete description, or with a narrative in which temporal relations are concerned. For these reasons it may make its appeal more strongly to the concrete ideation or to the logical function of the learner. Again, it may derive its data from different domains of sensation; and in its logical aspect it may be more or less abstract in character. Its logical coherence may be clear and readily comprehensible, or it may be obscure and complicated. The grammatical structure and the length of the sentences may be favorable or unfavorable for learning. And there comes in a wholly new factor,—the relation between the content and the form of expression; indeed the words themselves sometimes obtain a special sensory significance in virtue of their relation to the content,—the sound of the words may be more or less appropriate to the objects designated. Alliteration, assonance, rhyme, rhythm and meter, the variety and richness of the diction, all of these play a part in memory.

This enormous variety of factors which contribute to the learning of coherent material raises a host of interesting problems. Only a few of these problems have as yet received attention from the investigator; but the following phenomena have been observed. First of all, the existence of thoroughgoing differences between individual learners has come to light. These may be called types of rational memorization.

The materials employed by Ebert and Meumann were stanzas from Schiller's *Zerstörung von Orleans* and selected passages from a German translation of Locke's *Essay concerning Human Understanding*. Kraemer employed materials of various sorts: selections from Locke, and from Hume's *Enquiry concerning Human Understanding*, passages from Kleist's *Michael Kohlhaas* (narrative prose); from Mau's *Pompei*, Schmeil's *Lehrbuch der Zoologie* and Hertwig's *Physiology* (descriptive prose). The learners were asked to describe their mode of procedure; and these introspective reports were supplemented by objective determinations.

Ebert and Meumann's investigation revealed the following typical differences in method of learning: one observer (*Mn.*) learned exclusively from the meaning and the logical coherence of the material. He remembered the words of the poem and the prose selections only in so far as they expressed the meaning and the coherence of the content. The learning of the prose, which was chiefly of an abstract character, was characterized by the fact that attention was directed more exclusively to the meaning and the grammatical connection of the sentences than in the learning of the poetry; while in the poem the most concrete envisagement possible of the events, actions, persons, and places served the memory as a starting-point for the work of imprinting the words. The retention of the words was facilitated more by their concrete content than by their abstract relations. At times, Schiller's poetic diction led the learner to attend to the sounds of the words, to the rhythm, and to the lengths of measures, words and sentences. Still these sensory elements always served merely as secondary aids to memory.

The procedure of some of the other observers was wholly different. In their cases, the verbal and grammatical elements of the text played the leading rôle in imprinting even in the

act of significant learning. They attended chiefly to the visual elements,—the length of the words, sentences and parts of sentences, to their position in the line, in the stanza or in the paragraph, and to the sentence construction; or to the auditory elements,—the sounds of the words, the inflection and the rhythm of their own voices, especially to the relative strength of accentuation, to rhythm and rhyme, to the recurrence of the same letters or sounds at the beginning of words, to unusual words which are not current in common diction, and the like; or to sounds which are difficult to pronounce, and to the succession of vocal innervations. On the other hand, in these observers the sense and significance of what they learned played only the rôle of an auxiliary to the sense-memory. This shows us that even in learning significant material, one person remembers chiefly by means of sensory elements, another chiefly by the meaning of the content. In the latter case the sensory elements, whether auditory-motor or visual, are only occasionally summoned as aids when the learner finds that a certain word will not take hold and cling; or the sensory elements may occasionally force themselves into the focus of consciousness in virtue of their unusual or striking character.

A second difference between individuals results from the fact that the meaning of what is learned is envisaged chiefly in concrete images by some observers, while by others the imprinting is accomplished in terms either of the logical coherence or the grammatical structure of the sentences, or, in certain cases, in terms of temporal coherence. A third typical difference consists here again in the fact that certain observers set out to learn the total body of material as a whole, imprinting the single sentences or lines of verse as parts of the stanza, and the stanzas as parts of the whole connected poem; the attention of these observers is directed

to the total context. In opposition to this procedure, other learners link together, piece by piece, the various lines, sentences and stanzas, and the parts are thus connected up into a whole. The attention of the former type of observer is a total attention; that of the latter functions in a series of discrete acts, each directed to a single detail. The one attention is analytic; it proceeds to analyze what has first been grasped as a whole. The other is synthetic; it constructs a whole from a number of parts.

We find here a recurrence of the fixating and the fluctuating types of attention. The observer who possesses a fluctuating attention reaches out in advance of his reading, and reaches back as well, not only with his internal but also with his external regard; the fixating type reads and learns, in a strictly successive fashion, whatever appears before his progressively advancing regard. One is tempted to speak of yet a fourth typical difference; but it seems doubtful to me whether this type is to be placed upon a level of fundamental significance with the foregoing. In all psychological experiments, including, of course, memory experiments, it is observed that certain learners tend to employ all possible secondary associations of their own devising, while others wholly refrain from using these devices and confine themselves to what is given them. In some cases, the former devise mnemonic aids which connect the parts of the material with one another; in other cases, they make reinforcing movements or they construct peculiar spatial schemata into which they arrange what is to be remembered, and the like. The most of these secondary aids disappear, however, during the course of progressive experimentation, and the learning is confined more and more to the text which is furnished. These auxiliary means appear, therefore, to be a matter of habituation; they do not seem to imply the existence of essential differences in the organization of memory.

Kraemer was able to establish these typical differences in learning more securely because he prescribed a variety of conditions under which the act of learning was to be performed. In one case the learners were instructed to attend only to the meaning; in another case their attention was directed, so far as possible, to the verbal and sensory elements of the material; and in a third case they were to attend to both form and meaning. Kraemer also employed the method of interrupted reading; here the act of learning was broken in upon after a certain number of readings and the amount which had been learned up to that point was determined. His results show that the direction of attention to meaning proved to be the most advantageous procedure throughout. For adults, then, a thorough understanding of the content and particularly a complete knowledge of the logical connection of the sentences constitute not only the most important but the indispensable factor of all learning and remembering. When the learner relies upon the sensory details of forms of expression his learning is, in most instances, attained only after a great many readings of the text; and even then he does not usually understand its meaning. And even those individuals, whose act of learning seems to be based chiefly upon the words of the text, employ the words only as a secondary aid for the attainment of logical memorization. All three investigators,—Ebert, Meumann and Kraemer,—have made the important observation that the act of learning a material of any considerable extent starts out from certain "corner-stones" of retention; and the procedure consists in first laying these "corner-stones" securely and then supporting the rest of the learned material upon them. These may also be regarded as crystallization-points around which the whole chain of associations is formed. In the case of the type which learns exclusively from meaning, these supports are the

centers upon which the whole logical context hinges; for the other type of learner, striking words or phrases, verbal antitheses or repetitions also constitute starting-points of retention.

Apart from these individual variations, however, our investigations of significant learning have yielded a number of results which are pedagogically important.

1. In the case of coherent and meaningful materials the chief memorial support consists in the apprehension of the meaning and the logical context; and as a matter of fact, the process of learning takes its start from the dominant thoughts of the text. These are learned first of all; and the rest of the content, which the learner himself regards as subsidiary, is wholly ignored at the outset. The natural pedagogical inference is that the memorial acquisition of all meaningful material can best be facilitated by clearly explaining to the pupil the context and coherence of thought of the whole material.

2. In order to accomplish this it is necessary *a.* that the learner should grasp the leading thoughts, and *b.* that he should pay particular attention to those parts of the text upon which the essential progress of the thought or the development of the argument is based. The subsidiary parts of the text may then be learned with relative ease because they enter into union with the dominant thoughts.

3. Besides these points which are (objectively) significant for the progress of the thought, it is chiefly those parts of the text, which are (subjectively) most readily understood by the learner, whose mastery constitutes the starting-point of the act of learning. It is important, therefore, that in teaching, these parts should be discovered and that attention should first be concentrated upon them.

4. In the act of learning, a special significance attaches to the associations which are already present in the mind of the

learner,—his habitual combinations of words, his habitual trains of thought, and his habitual modes of expressing his thoughts. These are grasped first of all; and these are most correctly reproduced. It is natural, then, for the teacher to infer that the new elements in the material to be learned will attach themselves with relative facility to what is already known, and that the weak learner should begin with the familiar parts of the material.

Those trains of thought and contexts of words, which although in themselves unfamiliar are yet similar to trains and contexts which are familiar, act in much the same way as familiar and customary associations. From this it may be inferred that if a new material contains memorial supports which are similar to former contexts of thought, they constitute the best starting-point for the act of learning; and the novel and unfamiliar parts of the content should be brought into relation with them.

5. The factors which we have briefly designated the chief supports of the process of learning are of three sorts:

a. When the memory material is a description of tangible objects or of concrete situations, or the like, the chief support of learning consists in the learner's act of envisaging their parts or properties as concretely as he can. In doing so, however, he must guard against superfluity of concrete envisagement; he must confine himself strictly to the content which is expressed in the text because the superfluous portrayal of objects by an act of imagination inhibits the function of memory. Concrete aids may contribute in a secondary fashion if they are employed to embody the abstract parts of the content; but this is an advantage only in cases where the individual endowment of the learner lacks auxiliary imagery of a concrete sort for the direct apprehension of the abstract thoughts.

b. When the memory material is narrative in character, its temporal relations constitute its most effective memorial factor; and these temporal relations must be definitely and accurately presented to the consciousness of the learner. Several sorts of temporal relations come into consideration here: the simultaneity or the succession of events; their duration; their recurrence; their rhythmic succession, when periodically recurring events are dealt with.

c. To these must be added the logical elements, among which the thought of cause plays an especially prominent part when the content is of the nature of a proof or an explanation.

Besides these chief supports of memory a great many secondary supports contribute to the process of learning. The following may be mentioned as secondary aids which owe their origin to the meaning of the text:

1. The most important of these secondary supports is the structure of the sentences. Its effect consists in the fact that: *a.* Simplicity of grammatical structure facilitates, while complexity of grammatical structure hinders the act of learning. *b.* Uniformity of sentence structure is an exceedingly valuable aid to memory, irregularity of sentence structure gives rise to an intensely inhibitory effect. *c.* Subordinate clauses are relatively well remembered when they are not too numerous or too difficult to understand; subordinate clauses which contain digressions or additions that seem to be superfluous or subsidiary interfere with the act of learning. *d.* The recurrence of identical introductory words or phrases,—in part—in part, now—now, and the like,—proves to be advantageous to learning. *e.* The length of the sentences is an important factor. Sentences of moderate length which can be apprehended at a single reading are most readily remembered; successions of short sentences are difficult to remember

as are also very long sentences. *f.* The rhythm of prose facilitates learning. The more smooth the rhythmic flow of the sentence, the more easily can its content be remembered, and *vice versa.* The effect of rhythm is greater, the more we attend to the wording of the text. *g.* Particularly striking words attract the attention and are for that reason remembered better. Such words may sometimes have an inhibiting effect at first; they attract the attention, and in the subsequent course of the process of learning they aid retention. On the other hand, if similar but not identical words recur frequently in the text, they interfere with the act of learning. *h.* Certain visual elements such as unusual handwriting, unusual syllabification, and the like, are of advantage only to the visual type of learner. *i.* All characteristics and peculiarities of the text which occasion external or internal localization, such as the noting of a striking passage in the line or on the page, constitute secondary supports of the act of learning.

2. We may also mention certain chief factors which constitute hindrances, and which are a product of the meaningful and grammatical elements of the text. Like the chief supports they are partly objective, partly subjective in their nature; that is, they are due in part to the nature of the material, and in part to the mental constitution of the learner.

Among the hindrances may be mentioned the following: *a.* Frequent recurrence of similar or synonymous expressions; this, however, does not prove to be equally disadvantageous for all learners because certain individuals are disturbed in an extraordinary degree by the frequent recurrence of synonymous words, while this factor is much less disturbing to other learners. *b.* Successions of many short sentences which are not grammatically connected with one another. *c.* The other extreme, immoderate length of sentences, is also disadvan-

tageous. *d.* Interpolated words, especially adverbs referring to place and to time, have a disadvantageous effect; indeed, they may furnish a very great obstacle if they interfere with the learner's obtaining a distinct perception of the connections between the parts of the text. All additions which appear to be secondary or superfluous as compared with the leading thoughts also tend to hinder the process of learning. *e.* The form of expression and the customary combination of words and phrases have a disadvantageous effect when a familiar thought is expressed in an unusual fashion in the text. The ordinary form of expression persists stubbornly in forcing itself upon the learner and can only be suppressed with difficulty by dint of learning the form of expression which appears in the text. This phenomenon is more prominent in cases where the material is learned by concentrating one's attention upon the meaning. *f.* There are certain other factors which may have an exceedingly disadvantageous effect, such as fatigue, unpleasantness, repugnance and the like.

These aids and hindrances of the act of learning take their origin chiefly from the meaning of the material which is learned; but there are also specific disturbances and obstacles which are due to the wording of the material. These are particularly effective when the attention of the learner is directed to the wording or to spoken material. Yet it is, in general, true that but few universal rules can be formulated for acts of learning which consist in verbal acquisition; certain general phenomena may be established, however, which relate to this sort of verbal learning. Their formulation will enable the reader to recognize the general nature of this type of learning which has recourse to the forms of expression contained in the text.

1. The memorization of the wording of a text is invariably the most disadvantageous procedure for the adult. It can

be relatively advantageous only when the learner possesses a distinctly verbal type of memory and when, therefore, his learning does not differ materially from meaningful learning. But even in individuals of dominantly verbal memory, an act of learning which proceeds by merely noting the words is always somewhat more disadvantageous than a learning which relies upon meaning.

2. When the wording of the text is learned apart from its meaning, the former may be completely memorized without the latter being apprehended in its context. And since this is true even of adults, how much more must it be true of children? The following important pedagogical inference may be drawn: Even a complete and perfect memorization of the wording of a text does not constitute a guarantee that the meaning has been grasped. Indeed, it happens even in the case of adults that the wording of the material may have been learned by rote, and yet the learner may have no knowledge whatever of the meaning of what he has learned.

3. The verbal memorization of a material which has thus been learned from the wording of the original enables one more readily to apprehend the meaning of the material when one's attention is subsequently directed to the latter. From this we may derive the pedagogical inference,—although it is not wholly innocuous,—that in certain instances where we have to do with pupils who possess a normal verbal memory but a sub-normal understanding, we may first have them learn the text by rote in a verbal fashion, and then have them proceed to acquire an understanding of its meaning, because the memorial mastery of the text facilitates the apprehension of its meaning. But we must bear in mind here that a special work still remains to be done which should never be omitted, namely, the acquisition of the meaning of the text which has already been learned by rote. This pedagogical rule is the

more worthy of note because in our experiments we observe that even the adult sometimes resorts instinctively to this device, learning by rote certain passages of the text which are especially difficult to understand and then employing his memorial mastery of the words as a means of acquiring the meaning of the context.

4. The meaningless learning of words always results in the remembering of parts but not the whole of the text.

5. The most important aids for the learning of spoken material and verbal expressions as such are attention to rhythm, attention to the sounds of the words, and the whole group of factors which have to do with the grammatical structure of sentences. The most important obstacles to verbal learning result from the fact that customary associations of words and customary forms of expression force themselves in upon the learner and prevent the unusual forms of expression which are employed in the novel text from coming into action. The other hindrances result from the foregoing group of obstructions which depend upon the structure of the sentence.

One of the most important results of our recent investigations of the process of learning is the discovery of the extraordinary influence which the different intentions or attitudes (*Einstellungen*) of the learner exert upon his whole memorial process and upon his memorial result. It may be shown that there is a highly differentiated attitude of learning, and that memorial results are determined in a highly differentiated fashion by the attitudes or intentions of learners.

In the learning of significant texts three attitudes are possible: *1*. An adjustment to the meaning as such; *2*. to the words as such; and *3*. to the meaning and the words together. Most individuals usually learn in a more or less random fashion in so far as this three-fold possibility is concerned;

their attitude assumes now one, now another of these three forms. Kraemer's results show, however, that the adjustment is very significant for the effect of learning, and that with rare exceptions adjustment to meaning is most appropriate, being even more advantageous than adjustment to meaning and words together. Adjustment to words alone is least advantageous, that is, most adults can best learn a significant material from its meaning, *i.e.*, by basing their process of learning upon an apprehension of the context of thought. But, remarkably enough, even adults differ widely in this regard, for we sometimes find students who learn a text almost as readily from its wording as from its meaning, and in some cases even more readily. During the act of learning, these individuals attend almost exclusively to the wording as such. But here again one finds individual variations, because in certain learners it proves to be a matter of prime importance whether they attend to meaning alone or to wording and meaning together, while in other learners this variation in adjustment of attention makes no difference. There are individuals, then, who learn most effectively when their attention is wholly one-sided and particular,—when they set out to acquire meaning alone, or wording alone, but not to acquire both together; and there are other individuals in whom it appears to make but little difference whether these different intentions are pursued separately or not, although, of course, this is not a matter of complete indifference in any individual.

From these experiments we deduce the following general rules of memory: *1*. It is always disadvantageous to distribute the attention over both form and content in the learning of meaningful material. *2*. The distribution of attention gives rise to an extravagant expenditure of energy and to a purposeless act of learning because the learner attends to now one, now another phase of the material; and in most

individuals an increasing mood of unpleasantness results from this increased work of memory. *3*. The mode of distributing the attention depends upon the memory type of the learner. If he is more verbal he may almost wholly dispense with meaning, while the more concrete or logical type must necessarily attend chiefly to meaning as such.

The memorial effect, the amount remembered and reproduced, depends upon the adjustment or attitude of the learner. The more his intention is directed upon the meaning, the more is a correct reproduction of the meaning attained; the more he intends to learn the wording as such, the more are the words alone mastered. And it is a significant fact that the words are more correctly reproduced,—and probably more permanently remembered as well,—if they are learned not by means of a divided attention but by means of either one of these two adjustments of attention alone; that is, this superior memorial result is attained not only in the case where the learner attends to the wording as such, but also in the case where he learns the wording from its meaning and imprints the words as bearers of meaning or as the vehicles of a particular train of thought.

Similar observations have been made in investigations where nonsense syllables were employed as material for memory. In these experiments, retention may be tested either by the method of free reproduction or by the method of paired associates. Now it has been observed that when the learner undertakes his task with the intention of learning for the paired-associates test he can sometimes succeed in recalling all of the associates for which he is asked while he is wholly unable to recite the complete series. And conversely when it was his intention to learn the series for the recitation test, he may be unable to recall each syllable when he hears its predecessor in the series although his recitation of the series

is fluent and free from error. This phenomenon shows that a specific intention in the act of learning has a specific effect upon the result.

It is pedagogically important that the pupil should know of the influence which his intentions exert upon the results of his acts of learning, because misdirection of his attention could be avoided and the formation of improper habits in learning could be obviated. It frequently happens that in the learning of a vocabulary the pupil directs his intention upon the spatial localization of particular words, and he learns their positions in order that he may, by this means, remember them better. This association may, in certain instances, be an invaluable aid to memory; but in this case it proves to be an obstacle to the ready employment of the words in his subsequent study of the language because they have been learned not as words but as groups which stand at a particular place upon the page.

Every distribution of the learner's intention and every improper adjustment of his attention is to be regarded as an undesirable by-product which tends to diminish or to impair the chief product of the act of learning.

But notwithstanding the existence of these types of learning there are certain characteristics which are common to all learners. It is always found, for instance, that the learning of meaningful material is far superior to the mechanical learning of discrete items. There is, however, a lack of agreement in the statements of the various authors who have endeavored to make a quantitative comparison of the effects of these two sorts of learning. The learning of meaningful material varies with the degree of difficulty of its content; and it is therefore impossible to compare logical with mechanical learning excepting in an inaccurate and merely approximate fashion. Ebbinghaus found that stanzas from Don Juan could be repro-

duced without error on the fourth day after learning, while approximately the same amount of meaningless material had been so far forgotten that thirty-one repetitions were required in the act of re-learning them on the sixth day. From other experiments of Ebbinghaus and of Binet, the learning of a meaningful text of moderate length seems to demand only one-tenth of the time required for mechanical learning. In Binet and Henri's[1] investigation of the retention of words and sentences by school children, it was found that an average of twenty-five times as many words were retained when significant sentences were presented as when disconnected words were employed.

As regards methods of learning, our experiments showed that for significant material the whole-procedure (*Cf.* p. 233) or one of the mediating methods (*Cf.* p. 253) is by far the best. Indeed the whole-procedure does not manifest its complete superiority over the part-procedure in all of its forms until we come to deal with significant material. The distribution of attention, the uniform regularity of concentration is most advantageous when the whole-method and the mediating methods are applied to significant material.

A question which is of especial importance in the pedagogical application of investigations of significant learning is this: How do significant and mechanical learning act in combination with each other? Modern school-practice very properly insists that all memorization and retention should be preceded by as thorough an interpretation of the material as is possible, and that a complete understanding of the meaning of the content should constitute the basis of all memorizing. "Rational learning" is therefore to be preferred over every sort of "mechanical learning." From this, however, the con-

[1] A. Binet et V. Henri, La memorie des mots et la m'moire des phrases, *Année psychol.* I., 1895.

viction seems to have arisen in many quarters that there exists a purely logical memorization from which every mechanical element of mere repetition is lacking, and that this purely rational memorization is the ideal type of learning for which to strive in school-children. If this view of learning were taken seriously, a complete confusion of memory and a universal fragmentariness of retention would necessarily result. Psychological investigation shows us that in all memory material which is to be reproduced with accuracy, and which is to become the permanent possession of mind, a mere initial apprehension of the content does not suffice; but that in all learning which is to leave lasting traces upon consciousness the mechanical element of sheer repetition must play a part. Indeed it is found that mere repetition has exactly the same importance for significant as for mechanical memorizing even though the number of repetitions is less in the former case. Repetition, repeated imprinting, reading, speaking, reciting, all of these play a characteristic and independent rôle besides that played by the energy of attention and by an apprehension of the meaning. In investigations of permanent retention we discovered that when a learner found himself unable to concentrate upon his re-learning on account of unfavorable psychophysical disposition, and therefore worked with diminished attention, he sometimes endeavored to compensate the unfavorable bodily or mental condition by an excessive accumulation of repetitions. It invariably happened, in such cases, that more enduring traces remained in consciousness and that the material was remembered longer.

We found a somewhat similar phenomenon in a comparative investigation of the influence of rhythm upon learning. It turned out that a poetic meter had a particularly inciting effect upon the observer; he learned with heightened attention and in more pleasant mood, and by these means

effected a saving of repetitions. But when permanent retention was tested, we found that the series were not retained so well as series with unfavorable rhythm which had been learned with apparently the same degree of thoroughness, but by dint of a greater number of repetitions. Experiments dealing with immediate retention show even more clearly the necessity of mechanical memorization. In the determination of the limit of immediate retention of significant passages, the retention of the last sentence which can just be reproduced without error is in no particular different from the retention of a group of meaningless elements. A very few minutes after he has written it down he finds himself unable to reproduce it completely and correctly. Everything which is to be remembered permanently must be acquired and secured by means of repeated memorizations. And if a text is to be memorized word-for-word, the repeated memorization must contain a purely mechanical element,—namely, the sheer association of the visual-auditory-motor elements of the heard and spoken words. No one is able to acquire a *verbatim* remembrance of a poem of six stanzas by simply obtaining a clear understanding of the ideas and thoughts contained in it, or by simply imprinting these ideas and thoughts in their consecutive order because, in the first place, there is no unequivocal relationship of association between any chain of ideas and any series of verbal expressions, in consequence of which the words might be discovered from ones knowing the ideas; and, in the second place, all of the ideas of the poem are themselves conditioned by the choice of words. Our memory must therefore devote a certain amount of energy to the mechanical imprinting of the verbal material itself if verbal memorization and retention are to ensue. This mechanical element may recede far into the back-ground of consciousness, as it really does in the case of that learning-type which directs its

attention to the meaning and makes use of the non-significant elements of the word in a more secondary fashion; nevertheless the mechanical element is invariably present. A more important condition which forces us to memorize in a mechanical fashion has been found in the fact that we are obliged to make our reproduction in vocal form, and that we learn by means of a process of speaking. From this has been drawn the erroneous inference that the motor associations of the act of speaking constitute a group of mechanical associations which are fundamental and indispensable to the act of learning. But this can be true of only the motor type of learner. In the visual and auditory types, the visual and auditory elements of words may become so securely associated that vocal movements are automatically reinstated in the act of reproduction in virtue of the perfectly facile association-paths of the visual-verbal and auditory-verbal centres in the cortex.

If then the factor of repetition and at the same time the mechanical association of concrete verbal images play a part in all verbal memorization, then learning by means of repetition must not be under-estimated or neglected by the teacher. A lasting permanence and an accurate verbal reproduction of what has been learned is acquired by the child only through the agency of genuine memorization.

These statements must, however, not be misunderstood. They do not mean that a clear grasping of the meaning and a constant attention to the logical connection of what is learned are merely secondary matters; nor do they mean that the sensory and mechanical elements constitute the essence of learning. If this were true how would it be possible to explain the extraordinary superiority of significant learning over mechanical learning? On the contrary, the mechanical acquisition of sensory and motor elements in verbal learning,

and the manifold repetition of the material must be subordinated to the apprehension of meaning whenever possible. But on the one hand, mechanical learning must undertake the task of securing and making fast the material which is attentively grasped and understood, while, on the other hand, it alone can give fluency to the reproduction of the verbal material.

Now, since it is so much easier to learn significant material than to learn incoherent items, the question arises: Does this fact not justify the systems of mnemonics which are in current use? These, as is well known, endeavor to facilitate the remembering of numbers, names, and other disconnceted data by introjecting an artificial coherence. For instance, letters are substituted for the dates of accession of the German emperors. As a rule, only consonants are employed primarily but vowels are interpolated in order to build up significant words from the consonants. A sentence is formed from several words of this sort; the sentence is relatively easy to remember, nor is it difficult to re-construct the dates from the words in the sentence. By means of this and similar devices which always depend upon the introduction of artificial ideas of an intermediary and auxiliary sort, mnemonics teaches one to remember every conceivable sort of material,—numbers, names, foreign vocabularies, grammatical rules, and the like. The mnemonic principle in itself is not inconsistent with psychology. If one finds it easier to remember discrete and disconnected data by bringing them into artificial association with one another, no psychological blunder is made so long as the principle is not abused. But all of the directions which have been published for the construction of mnemonic aids employ a jumbled medley of the most heterogeneous aids to memory which cannot fail to confuse one by their unsystematic arrangement. At one time, they rely upon similarities

of sound; at another, upon logical relations,—which are usually falsely stated; at another, they have recourse to memory of locality; at another, they bring in a complicated substitution of other letters or numbers, and the like.

Apart from this, however, the whole mnemonic principle is as uneconomical as it possibly could be. It is at variance with the natural tendency of memory to retain only what is absolutely necessary;[1] and at the same time, it burdens the learner with a cumbrous mass of auxiliary ideas all of which must gradually be weeded out again if a fluent and reliable reproduction of an experience is ever to take place. Those, therefore, who at first make enthusiastic use of mnemonic devices usually abandon the system ultimately because no one will permanently bear this burden of purely auxiliary ideas. This criticism may be expressed in quantitative terms. Anyone who masters a foreign language must learn a vocabulary of approximately four thousand words. If now he introduces three auxiliary ideas, on the average, between the word of his mother tongue and the word of the foreign language his memory must carry an extra burden of twelve thousand words. But there are other psychological principles, such as the effect of mediate and immediate associations, which reveal the disadvantages of systems of mnemonics. The continuous use of mnemonics in teaching must be distinguished from an occasional employment of particular mnemonic devices by means of which one can sometimes make it easier for pupils to remember a date, the meaning of a word, or the like. There is, of course, no objection, psychological or practical, which can be urged against such an occasional use of memorial aids. And if, as is supposed by certain psychologists, it should turn out that there is a special mnemonic type of memory, we should, of course, place no obstacle in the

[1] See pages 315ff.

path of pupils who endeavor to remember everything by means of secondary associations, because that may be their normal and typical mode of remembering. But to base the whole formal education of memory upon a mnemonic foundation would be decidedly objectionable for reasons already cited. The technique and economy of learning by logical apprehension or learning by means of understanding or the rational combination of ideas has not yet been included in our discussion. The psychological investigation of this sort of memory work, however, is still in such a backward condition that we must be content with the references which have already been made to it.[1]

6. *Experimental Investigation of the Effect of Learning. Stages of Learning; Retention and Forgetting.*

The effect of learning is usually conceived to consist in a "retention" of what has been learned; but since the existence of retention can be revealed only by an act of reproduction, we may estimate the effect of learning in terms of reproduction. As a matter of fact, however, the first effect of learning comes to light in the act of learning itself, in that previous repetitions affect subsequent repetitions in a definite fashion, and the process of imprinting passes through several clearly distinguishable stages.

Before we consider these stages, it should be noted that in the investigation of memory we ordinarily employ the effects of learning as a means of designating the attributes of memory. We make a distinction between memories which acquire their material with ease or with difficulty, and between memories which reproduce their content with ease or with difficulty. We speak of a faithful memory, designating by this term the accuracy with which the original impressions are retained and

[1] See pages 290ff.

reproduced; of an extensive memory, referring to the number and variety of items which are retained; of a tenacious memory, referring to the length of time during which impressions can still be reproduced with a certain degree of vivacity and completeness.

Let us first of all consider the effect of learning in the act of learning itself. We know that learning passes through several stages. The first stage may be called that of the adaptation and orientation of the learner. The first few readings of a material,—or it may be the very first reading,—serve to adapt the learner to the activity of learning and to the material in hand; by this means he becomes oriented to the material which is presented to him. When nonsense syllables are presented, he usually discovers at this early stage which rhythm of learning is most suitable, and he becomes familiar with the auditory and visual impressions of the syllables.[1] This is followed by a second stage,—that of passively receptive learning. The learner now imprints the essential material upon his mind by reading, hearing or speaking, meanwhile assuming an essentially receptive attitude. This is followed by a third stage where the material is tentatively recited, checked, and controlled by the learner. As a rule the observer reveals the advent of this stage by his external behavior; he looks away from the text and anticipates the forthcoming parts of the material. This stage is usually manifested, in the case of nonsense syllables, by an involuntary acceleration of the tempo of speech. The fourth stage is characterized by a

[1] *Cf.* the introspections of observers in the papers of Ebert and Meumann, Pentschew and Radossawljewitsch; see also M. K. Smith, Rythmus und Arbeit, *Philos. Studien*, XVI., 1900., 61ff. G. E. Müller, *Gedächtnistätigkeit und Vorstellungsverlauf*, Leipzig, 1911; and especially Franz Nagel, Experimentelle Untersuchungen über Grundfragen der Assoziationslehre, *Archiv f. d. gesamte Psychologie*, XXIII., 1912, 156–253.

final fixing and strengthening of the uncertain parts whose difficulty the learner discovered in his tentative recitation, and by a genuine associating or synthetizing in consequence of which the learner now begins to feel that he is able to reproduce the material from memory.[1] The emotional state of the learner also experiences marked changes during these four stages of learning. The first stage is usually attended by unpleasantness and tension or by alternating emotional states and, in proportion as the subsequent stages arouse a consciousness of progress and success, a pleasant mood ensues.

The act of learning also has its definite effect in retention and forgetting. Before we can make this clear we must bear in mind that the purpose of learning is not always the same. In one case, we may endeavor to obtain a permanent imprinting, in another case, only a single reproduction. Now, it is most desirable that memory should not retain everything which it receives; and it is no less desirable that everything which is to be remembered permanently and accurately should be memorized in the real sense of the term. Non-psychologists have frequently been heard to complain that memory oftentimes fails us, and that we frequently find ourselves unable to give an account of our everyday surroundings when we endeavor to remember them. I have frequently convinced myself that this is true. I made systematic enquiries of a number of students as to whether they could describe the wall-paper of the rooms in which they studied; whether they could describe the dishes which they used every day at table; how many steps they ascended daily in the university stairways; whether they could name the buildings

[1] Special experiments devoted to this topic indicate that this synthesis is not a purely associative act; but this is a psychological question whose discussion would carry us too far from our present subject.

which they passed every day; whether they could describe or sketch the most striking church spires of the city; whether they could sketch the outline of mountain-peaks which they have seen often and attentively; whether the four upon their watch dials is indicated by four I's or by a IV, and the like. To all questions of this sort one obtains exceedingly uncertain or even erroneous answers. Remembrances of everyday experiences are frequently so uncertain that the student becomes vexed and wishes to discontinue the experiment.

These and similar observations prove that memory fails to retain many impressions that come to us countless times during our lives. They prove further that it is not the mere repetition of impressions as such which constitutes imprinting, and makes it possible for us to reproduce, especially to reproduce freely; on the contrary we find that, as a rule, we remember only what we have apprehended attentively and with the intention of remembering it. However necessary then the factor of repetition may be for retention, it seems to render a subsequent free reproduction possible only when it constituted an intentional acquisition by consciousness. We must not reproach memory because everything which it did not acquire by intentional and repeated acts has been allowed to lapse or is not freely reproducible. Consciousness would indeed have an exceedingly heavy burden to carry if the countless trivialities which we daily experience were all so deeply imprinted that they were "retained" and acquired a tendency to be reproduced. The limited compass of consciousness forbids our being occupied with many ideas at any one time. The struggle of ideas for possession of the narrow field of consciousness would be immeasureably increased if memory were not limited to the relatively narrow domain of those impressions which were intentionally noted. There is yet another characteristic of memory which sustains us in the

presence of this alleged defect of practical life. This is the familiar phenomenon that it is easier to recognize than to reproduce. Countless things are recognized when we perceive them again although we could not have called up a free memory-image of them in the meantime. For practical purposes it is sufficient that we should recognize the things which we know; it is by no means always essential that we should be able to reproduce a free idea of them.

In the interests of psychology and of pedagogy, the accurate investigation of retention and forgetting has frequently been attempted. It is particularly important that we should know how rapidly impressions, which have once been received, disappear from consciousness again; in what manner forgetting is dependent upon sort of impression, upon our apprehension and imprinting of it, upon the individual characteristics of the learner, upon an occasional renewal or refreshing, etc. These latter determinations would furnish us with reliable data which, in turn, would constitute a basis for the systematic introduction of repetition into the courses of study in the school-room.

When we approach this question experimentally we must bear in mind the different functions of retention which have been described in the foregoing discussions. Memory is characterized by two wholly different sorts of retention,—immediate and lasting retention. We may also designate them as primary memory, and secondary or mediate or genuine memory.[1] It is instructive to compare the effects of retention and forgetting in each of these memory functions. Such a comparison discloses the extraordinary superiority of permanent retention over immediate retention. Immediate retention dies down in consciousness very rapidly, and the more so, the more nearly the number of impressions to be retained approximates

[1] *Cf.* pp. 40ff.

the limit of our power of retention. For instance, if we read aloud to an observer as many letters as he is just able to reproduce immediately thereafter, his power to reproduce them will frequently be found to have disappeared entirely within a few seconds, provided no new imprinting of the material has taken place in the meantime.

Immediate retention is easily improved by formal training. Unpractised adults are ordinarily incapable of immediately reproducing more than eight or ten letters at the most, but practised observers can reproduce twelve or fourteen. Significant texts are correctly reproduced, immediately after presentation, to a much larger extent. The effect of practice in immediate retention is not very great; but it must be noted that the addition of only a few items may make the task much more difficult. The limit of achievement of immediate retention may here be illustrated by citations from our numerical results; but of course it depends upon the observer's practice, upon the sort of material chosen, and upon other conditions as well. When letters or digits were employed, one of our observers succeeded in reproducing thirteen to fourteen correctly; with nonsense syllables, eight to nine; words, twelve; stanzas of poetry, twenty-four words; prose selections, thirty-six words. The child's limit in this function of memory is considerably less than the average limit for adults. This is apparent from the experiments which dealt with the numerical determinations of the compass of immediate attention.

The limit of immediate retention in school-children has been determined by several investigators; and similar methods have been employed in all of these experiments.[1] Bolton

[1] T. L. Bolton, The Growth of Memory in School-children, *Amer. Jour. Psychol.*, IV., 1892, 362–380; B. Bourdon, Influence de l'age sur la mémoire immediate, *Revue philos.*, XXXVII., 1894, 148–167; A. Binet et V. Henri, La mémoire des mots, *Année psychol.*, I., 1895,

and Jacobs employed auditory presentation; they read short lists of monosyllabic numbers which were written by the children immediately after hearing each list. Binet and Henri read seven series, each containing seven disconnected words, and had the children write down what they remembered. They tested three hundred and eighty children, from eight to thirteen years of age. Then they read significant sentences, which likewise were written down immediately from memory by the children. The same general method was also employed by the later investigators. I have improved upon it in the following manner: In my systematic investigation of the compass of immediate retention the children were first given three, then four, then five words, continuing up to eight; the words were read aloud to the children who were required to write all that they could remember immediately afterwards. This modification adapts the experimental procedure to the age of the child. Binet and Henri used a list of seven words for eight-year-old children. This number is too

1–23; La mémoire des phrases, *Ibid.*, 24–59; J. Jacobs, Experiments on Prehension, *Mind*, O.S. XII., 1887, 75–79; E. Meumann, *Vorlesungen zur Einführung in die experimentelle Pädagogik*, Leipzig, 1907. I. Schuyten's experiments are reported in the *Bulletins de l'Academie Royale de Belgique*, 1905, and in the *Paedologisch Jaarboek* from 1900 on. See also M. Lobsien, Das Gedächtnis für bildlich dargestellte Dinge, usw. *Beiträge zur Psychologie der Aussage*, II., 1905; Bernstein und Bogdanoff, Experimente über das Verhalten der Merkfähigkeit bei Schulkindern, *Ibid.*, II., 1905, 115ff.; Ebert und Meumann, *Grundfragen der Psychologie der Uebungsphänomene im Bereiche des Gedächtnisses*, Leipzig, 1904; Decroly et Degand, Experiences de mémoire visuelle verbale, etc., *Année psychol.*, XIII., 1907; W. H. Winch, Immediate Memory in School Children, *British Jour. of Psychol.* I., II., 1904–6; Louise Ellison, The Acquisition of Technical Skill, *Pedagogical Seminary*, XVI., 1909. See also the Reports of the Board of Education of the Chicago Public Schools, containing reports of experiments by Smedley, Cooley, Macmillan and others, Chicago, 1899ff.

great; it readily confuses the child. Schuyten dictated lists each containing eight two-place numbers; and here again written records were made by the children.

These experiments show, first of all, that immediate retention throughout all of the classes of the public school is less efficient than in adults. Furthermore, immediate retention develops very slowly, and has not reached its maximum capacity at the age of thirteen or fourteen years, the age at which the child leaves the public school. The pupil of the high school is better off in this particular. The most important part of his mental training comes during those years when memory has approximately reached its greatest efficiency. Comparative data for children and adults, which I have obtained from observers up to the age of forty-six years, show that up to the age of thirteen years the development of immediate retention is very slow; from thirteen to about sixteen there is a more rapid development. At the age of twenty-two to twenty-five the adult student reaches the limit of his capacity of immediate retention; from there onward the capacity remains stationary in most persons. Bourdon found a slight growth of immediate retention between the ages of fourteen and twenty years, when tested with meaningless or relatively discrete material.

Bolton reports that the development of immediate retention does not run parallel with the development of intelligence but with increase of age; that is, older children have, on the average, a better memory than younger children, and increase of age is the chief factor in the development of memory. My investigations show that in the majority of cases intelligent children are also equipped with better memories; this does not, however, constitute a parallelism in the developmental progress of the two functions in question. The investigations of the *Société de psychologie de l'enfant* in Paris also

show that intelligent children have on the average a more efficient immediate memory.[1]

The children investigated by Binet and Henri retained, on the average, 4.7 and the adults 5.7, of the seven words dictated to them. This result is clearly too low for adults. Children of eight to nine years retained an average of 4.6 words; ten to eleven years, 4.9; eleven to twelve years, 4.8; twelve to thirteen years, 4.9. According to my experiments, the memory capacity of eight-year-old children is less than these data indicate; they retained an average of four words, while children of thirteen to fourteen years retained an average of 5.6 words. A comparison of some of the extreme findings is more instructive. Among the seven-year-old children I found a great many who never succeeded in retaining more than three words and two nonsense syllables, while a great many of the fourteen-year-old children reproduced eight words correctly. The best observers among my practised adults retained as many as twelve words, and in correlate experiments sometimes succeeded in retaining fourteen discrete letters.

Decroly and Degand extended the investigation of immediate reproduction to children, five to ten years old, in a kindergarten school in Brussels. The results of these experiments show that simpler impressions are by no means better retained but that facility and fidelity of immediate reproduction increase in proportion as the material is more familiar to the child; they also show that in children, as in adults, sentences which express unitary concrete thoughts are more readily attended to and remembered than isolated words, and much more readily than syllables and letters. Small cards upon which letters, words or sentences were written in red ink were shown to the children who were allowed to look

[1] See the bulletins of this Society, published by Alcan, Paris.

at them for thirty seconds. The sentences were remembered better than the words or the letters. In a second series of experiments nine letters were shown to normal and abnormal children who were then asked to select these letters from a group of twenty-six; similar experiments were made with geometrical figures and pictures. In these recognition-tests of immediate memory, pictures were remembered better than letters or geometrical figures; and it was also found that words contained in sentences are remembered better than isolated words.

In an investigation of the immediate retention of visual and auditory words, Winch undertook to solve the following problems: Can "pure memory," —or memory of data which are associated only in time and space,—be improved by practice? Does "pure" memory improve with increase of age and of mental proficiency? In a first series of experiments, twelve consonants written in three columns were presented for a period of thirty-five seconds to children from eight to fourteen and a half years of age. In one case, written reproductions were made immediately, in another case, after an interval of twenty-five seconds. Although the temporal interval was brief it is remarkable that Winch found no difference between the results of immediate and delayed reproduction. Repeated tests showed that this fundamental function of memory manifests a distinct and regular improvement as the result of practice. Winch also found that memory improves with increase of age and general proficiency, and that a definite relation obtains between memorial excellence and intellectual proficiency. In a second series of experiments, Winch tested the immediate auditory memory of thirty-six girls. These girls represented the average ages and the average degrees of intelligence of the second to the seventh classes, inclusive. Twelve consonants were read aloud to these pupils,

with pauses after the fourth and the eighth consonants; each consonant was read twice, twenty-five seconds being devoted to the two readings. The consonants were then reproduced in writing, and after one minute and thirty-five seconds the next experiment began. Notwithstanding every precaution, the pupils sometimes formed significant words from the consonants, for instance, *sir* from *sr*, and *Ted* from *td*, but only by six of the thirty-six pupils. All ten of the tests were made on the same day of the week and at the same hour of the forenoon. Winch reports that immediate retention shows a distinct and fairly uniform improvement as the result of practice; that school proficiency and efficiency of "pure" memory usually go hand in hand; and that when the comparison is limited to children of the same age and school-class, the same correlation holds although it is less conspicuously present.

The experiments of Smedley and Cooley dealt only with the immediate reproduction of numbers, but they attempted to analyse retention into its component processes and to trace the development of auditory, visual, vocal-motor and manual-motor memories of numbers, independently; the visual and auditory acuity of the pupils was also tested. Smedley presented ten series of four to eight numbers to pupils between the ages of seven and sixteen years. Four modes of presentation were employed,—the numbers being seen; seen and heard; seen, heard and pronounced; seen, heard and written by the pupil. Two objections may be raised against this procedure. The sort of memorial function employed by the pupil is not necessarily identical with the sort of stimulus presented by the teacher; and the author himself states that some of the pupils found it impossible to repress their vocal innervations during the auditory tests. Moreover the ideational type plays such a prominent part in immediate retention that no matter what may be the mode of presentation of

a verbal material which is reproducible in more than one modality, many individuals transform the presented material into their own typical modality; for instance, the auditory individual attempts to remember by means of auditory images when verbal material is presented to him visually. For this reason such experiments do not warrant any inference as to the development of the several memories unless each sense-memory is compelled to function independently, and unless the observers are classified into ideational types by means of a special investigation. The former condition can be only approximately fulfilled and the latter can not be fulfilled in the class-experiment. As to the practical application of the results of these experiments it must also be borne in mind that the most favorable condition for retention is not provided when the mode of presentation is made as many-sided as possible (auditory-visual-vocal-motor), but only when the mode of apprehension is relatively circumscribed and when it conforms to the ideational type of the learner. This comes to light in the Chicago experiments where numbers which were seen and heard by the pupil were sometimes remembered better than numbers which were seen, heard and written. My own observations show that this phenomenon is due to the fact that, in the absence of special practice, it is more economical to employ our customary modes of learning; and that these modes are a product in part of congenital type and in part of habit. So soon as a memorial means which does not correspond to the congenital or the acquired factor comes into play, a part of the energy which should be devoted to attentive apprehension is expended in the act of learning the unaccustomed material which does not conform to the learner's typical modality. And that is just what happens in the case of most pupils when they are asked to write their memorial material, because they are not accustomed to learn words by writing

them since the manual-motor type of memory is rarely found.

It is not to be assumed then that the results of these experiments nullify the law which was empirically established by Muensterberg and Bigham,—namely, that we remember well in proportion as we have recourse to many associative aids,—because this law, of course, presupposes that the several associative aids are equally facile and familiar to us. On the contrary, we are impelled by general psychological considerations to assume that practice in the use of the several memorial aids must demonstrate that the law is valid throughout the whole range of memorial functioning.

If we assume that those modes of presentation where Smedley employed no unaccustomed memorial means are to be regarded as constituting normal cases of immediate retention, then it follows from his experiments that the average capacity of immediate retention increases by a considerable amount and in fairly constant progression up to the fourteenth year. In agreement with the findings of other investigators, its capacity almost doubles between the seventh and the fourteenth year, thence it improves more slowly but continues to improve up to the nineteenth year. Here again we see that development still continues after the last year in the public school,—a phenomenon which we see duplicated in all of the other higher mental functions.

Lobsien has recently investigated the development of auditory memory by testing the immediate reproduction of ten meaningless combinations of syllables. His material, however, was much too difficult; and material should not be presented solely in groups of ten elements if accurate results are to be obtained. Moreover, his investigation dealt with an intermediate function between immediate retention and genuine learning because the series were each presented five times.

He tested 2,788 boys and girls between the ages of seven and fifteen. He found that the average number of syllables retained was 2.33, about a quarter of the maximum capacity that was possible. The capacity of immediate retention of this meaningless verbal material increases progressively; but the unreliability of phonetically accurate reproduction also shows a considerable increase with increase of age. The improvement is not regular, but fluctuates periodically both as regards amount and fidelity of retention; and the periodicity differs in the two sexes. A striking lapse in efficiency is found at about the tenth year.

Now it must be borne in mind that this capacity of immediate retention, which proves to be so ill-developed, must be made use of at every moment by the child at school. Whenever the teacher asks him a question the child must "immediately retain" a sentence. Here, then, we have a psychological basis for the familiar rule that questions must be put to children in brief form. In all auditory instruction and oral response, in dictation, in mental arithmetic, and particularly in drawing, immediate retention plays an important rôle. In the act of drawing, the child must glance at the original or the model, and when he glances back to his drawing-board the immediate retention of what he has just seen comes into play.

In psychological experiments we endeavor to determine not only the compass of immediate retention, but also to discover what methods are employed by different individuals in their acts of immediate retention. Here again are revealed certain typical differences in procedure, which come to light not only in the behavior of attention but also in the means by which the primary impressions are remembered. The chief differences in types of immediate retention may be made clear by a description of two of my observers, whom I shall

call *D.* and *F.* The diversity in the procedure of these two observers was revealed in the sort of errors which they made in the immediate reproduction of letters and numbers. *F.*'s errors were usually misplacements,—he transposed letters or digits from their original order; while *D.*'s were usually phonetic errors,—he substituted letters of somewhat similar sound for the letters dictated to him. In visual presentation, *D.* was aided by the letters being printed closely together, but this feature had no significance for *F.* In a series of experiments where the tongue was held securely between the upper and lower teeth *F.* made more errors than *D.*,—the former being conscious of a strong impulse to withdraw the tongue while *D.* was not aware of any such tendency.

These facts show us that *D.* remembers chiefly in terms of auditory images of words, *F.* by means of vocal movements, ideated or executed. That, however, does not, by any means, constitute the essential difference between their modes of procedure; this consists rather in the different behavior of their attention. *D.* himself gave the following description: "While the experimenter is dictating I do not direct my attention to the individual letters, nor do I fixate my internal regard at all upon the series of words which I hear; but I turn my attention aside in order to receive the whole uniformly into the neutral and unconcentrated field of consciousness. Immediately after the dictation is finished, I have a very faint auditory image of the whole series. This soon clears up, and I write the whole series as rapidly as possible as though it were 'all in one piece.'" *F.* describes the behavior of his attention as being directly opposed to this: "I attend to each individual letter; and during the later process of writing them down I arrange the single items of the series one to another, assigning each to its place."

If now we express these introspections in more general

terms, we find that the two observers have wholly different behaviors of attention. *F.*'s attention functions in a discrete fashion; it turns to the particular letters, words, etc., in a series of successive acts, and the observer himself must combine these individual impressions into a series. The group or the whole is here built up from the individual items. On the other hand, *D.*'s attention is directed toward the whole; his is a sort of total attention. Consequently what his memory retains is the series; and the single items are remembered solely by means of the series and as parts of it. For this reason *D.* turns aside his attention or the focus of his consciousness while he is listening to the dictation of the series in order that he may not heed the several elements discretely and in isolation from one another, but may rather obtain a general impression of them as a series. The full work of attention does not begin until, with the completion of the dictation, the whole is before him. Now it is especially important that a definite and intimate internal relation should be found between the means employed by the memories of these two individuals and the modes of behavior of their attention. Or shall we regard it as an accidental circumstance that *F.*, who is more motor, should be the one who manifests the discrete type of attention? It is probably his motor method of retaining, that is, the necessity of accompanying every single letter with a special vocal innervation, which directs his attention to the items of the series; while, on the other hand, it is more advantageous for *D.*, who belongs to the auditory type, first to permit the individual items of his series of auditory images to fuse into a whole in order that he may then be able to reproduce the latter.

Now it may be shown that this difference in attitude and behavior of attention makes its appearance not only in learning but also in other and wholly diverse sorts of mental activ-

ity. In the experimental analysis of the act of reading, for example, we find that a wholly analogous difference comes to light in the reading processes of different individuals; some readers sharply fixate the particular parts of the word, while others invariably direct their attention to as large a group of words as possible,—to a "reading-field." In reading, then, the attention of one individual proceeds in a fixating fashion, that of another proceeds in a fluctuating fashion. I have no hesitation in asserting that this variation is to be regarded as a fundamental difference in the attention of different individuals, and that it is to be set on a par with those differences in concentration and distribution of attention which have been accepted by modern psychology.[1]

The foregoing results are, to some extent, supplemented by Binet and Henri's investigation of the retention of sentences by school-children. A comparison of these with our Zurich investigations of immediate retention in adults furnishes the pedagogically important result that, in this regard also, the memory of the child of school-age is considerably less efficient than that of the adult.

A summary of the investigations of immediate retention yields the following conclusions which are of interest to pedagogy: *1*. The behavior of attention and the means employed in retention show typical variations from individual to individual,—hence the conditions which are most favorable to retention must also be subject to individual variation. The auditory type finds auditory presentation to be most advantageous; the visualizer finds visual presentation to be most favorable. For the auditory type, the directing of the attention to the whole body of material and a certain divert-

[1] I have repeatedly observed this difference in children and adults; Mrs. Dürr has found it in children, and Albien in pupils from nine to eighteen years of age.

ing of attention is a profitable procedure; the motor learner finds it best to fix his attention sharply upon particular details. *2*. Errors made in immediate reproduction can be understood only in relation to type of ideation and of attention. *3*. The memory of the child is much less efficient in immediate retention than that of the adult. *4*. Individual differences in aptitude for immediate retention are very great both in children and in adults. Bright children retain twice as much as dull children of the same age.

All of these relations which we have determined for immediate reproduction have also been established for permanent retention. It is found, however, that so soon as we come to deal with permanent retention we are confronted by wholly new problems, such as: What influence does re-learning exert upon the process of forgetting? And this is an important question for pedagogy.

Ebbinghaus again is the experimenter to whom we owe the first accurate investigation of permanent retention and re-learning. He memorized many series of nonsense syllables,—each series containing thirteen syllables, and as a rule eight of these series were learned in succession. Each series was learned until he could just recite it from memory without error. After definite intervals of time,—twenty minutes, one hour, nine hours, one day, two days, six days, and thirty-one days,—each series was re-learned. The results of such a procedure must show the progressive course of the process of forgetting, first during succeeding hours of the day upon which the syllables were learned, and then through the ensuing days and weeks. It is unfortunate that Ebbinghaus usually recorded simply the time expended or the time saved in re-learning after the lapse of the interval, and employed these determinations as the measure of the amount of forgetting which had taken place up to that point. It would have been

more correct to determine not only the time but also the number of repetitions, and, so far as possible, the accuracy of reproduction. The chief results of these experiments were as follows: Forgetting proceeds rapidly at first, then gradually more and more slowly. Even within an hour after the cessation of the learning "more than a half of the work done at the beginning must be done over again," before the series can again be reproduced correctly. At the end of about nine hours the loss amounted to approximately two-thirds of the work done at the outset. From this point onward, forgetting proceeds more slowly. After twenty-four hours about one-third of what was learned is still present in memory; after six days, one quarter; and after one month, fully one-fifth is still present. This gradually retarding progress indicates that complete forgetting would, theoretically, not ensue until after an infinity of time had elapsed. From this behavior of memory Ebbinghaus derives the following general principle: Forgetting progresses not in direct proportion to the time elapsed but in proportion to the logarithm of the time.

Ebbinghaus's determination of the curve of forgetting has not been confirmed in the numerous investigations which have been carried on in my laboratory. A considerable deviation from the finding of Ebbinghaus was invariably found in the experiments of M. K. Smith, Magneff, Pentschew, and, in particular of Radossawljewitsch, who repeated the experiments of Ebbinghaus with twenty-seven observers. In the first place, it is certain that the results of Ebbinghaus show forgetting to proceed much too rapidly at the outset. When the act of learning has been continued to the point where one finds it possible to recite the material once or twice from memory, the amount of forgetting which occurs for a time thereafter is almost directly proportional to the length of the elapsed interval. Not until some little time afterwards does

a more rapid progress of forgetting appear; and this again is always followed by a rate of progress which gradually becomes slower and slower. Another striking divergence comes to light in connection with Ebbinghaus's finding that more has been forgotten after an interval of twenty-four hours than after eight hours, for instance, when the syllables were learned in the morning and the re-learning took place in the afternoon of the same day, eight hours later. We found that all observers remember more after twenty-four hours than they do after eight hours. It is probable that two factors contribute to bring about this state of affairs: A general mental fatigue makes its appearance during the day, rendering retention more difficult; and associations continue to gain in strength throughout the first twenty-four hours. This is the phenomenon of latent after-practice which may be shown by other means to exist. The progressive advance of forgetting as found by Radossawljewitsch is compared with that found by Ebbinghaus in the table[1] on opposite page.

The results reported by Ebbinghaus seem improbable in the light of every-day experience. What an unreliable instrument memory would be if it forgot as rapidly as Ebbinghaus believes! If to-day we are to succeed in reciting a body of material which we learned yesterday, we must do over again more than half of the work which we devoted to its initial memorization!

It seems desirable to bring forward additional evidence bearing upon this first point concerning retention and forgetting. We can obtain a direct measurement of the process of forgetting by determining the effect of re-learning upon retention and forgetting. And this determination may be made by discovering how the number of repetitions required for re-learning any material are distributed over successive

[1] Radossawljewitsch, *Op. cit.*, p. 83.

	Number of Experiments Performed by		Length of Interval Between Learning and Re-learning	Per Cent. Forgotten		Difference in Favor of Radossawljewitsch
	Radossawljewitsch	Ebbinghaus		Radossawljewitsch	Ebbinghaus	
1	24	—	5 minutes	2.5	—	—
2	24	12	20 " (Ebbinghaus, 19)	11.4	41.8	−30.4
3	24	16	60 " (Ebbinghaus, 63)	29.3	55.8	−26.5
4	24	12	480 " (Ebbinghaus, 525)	52.6	64.2	−11.6
5	47	26	1 day	32.2	66.3	−34.1
6	26	26	2 days	39.1	72.2	−33.1
7	20	26	6 "	50.7	74.6	−13.9
8	13	—	14 "	59.0	—	—
9	8	—	21 "	62.0	—	—
10	18	45	30 "	79.8	78.9	.9
11	12	—	120 "	97.2	—	—
Total	240	163				

days,—the material being learned or re-learned in each case until we know it by heart. This method was first employed by Ebbinghaus, who found that the number of repetitions required for learning the same material on consecutive days decreases in logarithmic progression. Thus, for instance, if 21.5 repetitions are necessary for the memorization of 24 nonsense syllables on the first day, the numbers of repetitions required on the following days are 10, 5, 3, and 1. The existence of such a state of affairs, however, seems to be very problematic because the first re-learning, on the second day, is much more effective than Ebbinghaus reports it to be. Our own determinations for consecutive days were (for 24 syllables) 21.6, 4, 1 and .7. From this it follows that the

first repetition is the prime factor in retention, and that subsequent repetitions serve only to intensify its effect. Pedagogical rules for the technique of learning may be derived from all of these facts; but particular heed should be paid to the stages of learning. The pupil who is made familiar with these stages will be more likely to guard against immature and imperfect learning, and hence will be spared a great deal of relatively useless work. In the class-room, material should always be thoroughly re-learned as soon as possible after its initial acquisition because this procedure will be found to aid retention in a most effective manner.

Ebbinghaus reports other findings which are of value to pedagogy. At each sitting he memorized six stanzas of Byron's Don Juan, and a series containing twelve, twenty-four or thirty-six nonsense syllables; and on the following day, at the same hour, he re-learned the same materials. In these experiments the difference between the number of repetitions required for learning and for re-learning, that is, the "saving" in repetitions, was taken as a measure of the amount retained. The results were as follows: *1*. As to the influence of length of series, it was found that the longer series were more indelibly imprinted,—that is, they were retained better; indeed, the groups of thirty-six syllables were imprinted almost twice as thoroughly as the groups of twelve syllables. Significant material was remembered very much better than meaningless material. The stanzas of poetry were re-learned on the second day with less than half as many repetitions as the shortest series of nonsense syllables required; and notwithstanding this, the memorial stability of the former was so great that no more repetitions were required for their refreshing on the next day than for the series of twenty-four syllables, *i.e.*, about one-half of the original number of repetitions. *2*. As to the influence of re-learning, the results revealed the remark-

able fact that the number of repetitions which the longest series of syllables required on re-learning decreased more rapidly than the corresponding number of repetitions for the shortest series; so that ultimately, upon a certain day, the longest and the shortest series were re-learned with the same number of repetitions.

Ebbinghaus employed but a single method of learning; and he wholly failed to determine which procedure in learning gives the most accurate and permanent retention. We have already mentioned the influence of procedure upon retention and forgetting. We need only repeat that material which has been learned in parts is more readily forgotten, and what has been learned as a single whole is remembered much longer. If, for example, an observer remembers thirty per cent. of a poem which he learned three months ago by the whole-procedure, he would be found to have forgotten almost the whole of it during the same interval if he had learned it by the part-procedure. Indeed, it sometimes happened, it is true, that stanzas which had been learned by the whole-procedure required more repetitions on re-learning than stanzas learned by the part-procedure; but, even in those cases, the former stanzas were remembered essentially better than the latter. Hence the whole-method again proves to be more advantageous in so far as retention for longer periods of time is concerned.

7. *The Education of Memory in the Schools*

The foregoing descriptions have disclosed a picture of memory function which is wholly different from that which psychology was accustomed to sketch in its non-experimental days. According to the older psychology, all remembering and reproducing depend simply upon laws of association; and no clear distinction was made between laws of association and

laws of reproduction. Instead of these laws of association we now have an analysis of the particular and the general conditions of memorization and reproduction in their extraordinary fullness and complexity. We have obtained an insight into the fundamental differences of learning-types, and into certain of the more essential of the general conditions of learning. The question will now arise: To what degree, and in what manner are the learning types capable of being systematically turned to account in learning, of being improved and developed, or of being levelled down and made identical with one another? We must also inquire to what extent and by what means memory, in general, is capable of being trained and improved. And finally it may be mentioned once more that the profound importance of formal memory training has been established in every memorial investigation where the training of memory as such was attempted. May it not be demanded, then, that the schools shall incorporate the formal training of memory into their curriculum?

A first demand which our psychological investigations lead us to make upon the schools is of a general sort: Memorization should not be a matter of accidental success as it has been in the past; nor should it be given over to the blundering efforts and the unsystematic groping of the child. It should not entail the waste of time and of energy which necessarily results from a desultory and fortuitous procedure. The teacher must raise it to a higher plane; and this he can do by directing his pupils in their process of learning and by adapting their activity to conform with the results obtained from investigations of the conditions of economical learning.

How can this be brought about? It may be accomplished in the following ways. Children should be instructed by the teacher in the proper use of their means of remembering and modes of reproducing, the instruction of course being made

more and more complete and thorough as the children become older. They should be systematically trained by practical memory exercises. The material employed in this training should be related as closely as possible with the material ordinarily learned in the school-room; its quality and its quantity should be graded to adapt it to the age and the capacity of the pupils. The formal purpose,—the training and development of memory itself,—and the material purpose,—the mental acquisition of the subject-matter,—should receive equal emphasis throughout.

As regards the theoretical instruction of the child in the use of his memory, this may include the following points: *1*. Pupils may have their attention called to the various means of memorizing through whose use the highest efficiency of memory is attained; and again the instruction may include either the particular means of memorizing, which are peculiar to particular persons, or the general means which are common to all individuals. This demand, of course, presupposes that the teacher himself has a mastery of the methods by means of which the memory-type of the child may be determined. A few minutes at the beginning of the first school-period should suffice for an examination of the memory types of certain children in the class; the tests could be made in the presence of other children, who would thus come to an understanding of the experiments which are to be made upon them later. In this manner a large class can be investigated within a few weeks. Where it is not feasible to make individual tests, the whole class may be investigated at once by means of one of the mass-methods, although mass-methods are always less reliable than individual tests. For instance, the pupils may be asked to record all of the visual, auditory, and motor ideas which occur to them in a given period of time, say five minutes; or the teacher may determine which children remember data

best from auditory presentation, and which find visual presentation the most favorable; or the pupils may be asked to report the first idea which occurs to them when a word is pronounced in their presence. In the latter case, one may gradually confine their choice of reproduced words within narrower and narrower limits; by this means, and by an appropriate selection of stimulus-words, the child's dominating imagery may readily be determined. The time required for the learning of a given material may be measured, and noticeable fluctuations of attention may be recorded. It is a simple matter to determine the compass of immediate retention for all the members of the class.

When we have determined the ideational type to which a child belongs, and have also determined his type of attention, it is then desirable to bring the essential features of his method of learning to the notice of the child himself, and to show him the advantages and the disadvantages of his procedure. My own observations show that these determinations and demonstrations are interesting both to the teacher and to the pupil. Through acquiring an insight into the mechanism of memory, children are led to take pleasure in the formal act of learning; while the teacher is enabled to ascertain the causes of success and failure in the memory work of his pupils, to acquire skill in diagnosing memorial weakness and memorial strength in particular pupils, and to develop an ability to direct his pupils to a proper and effective employment of means which may be made to contribute to memory. He sees that the attention of one pupil adapts itself with difficulty to the material and to the act of learning, while that of another adapts itself readily and securely; that one child is inclined to remember chiefly in terms of sensory elements while another tends to employ non-sensory elements; and that the former child's procedure consists chiefly in calling up material

concretely before his mind, while the latter relies upon his power to apprehend the logical coherence of the material. He sees, too, that the attention of one is attracted by the whole,—the parts being remembered by means of the whole,—while that of another is directed to particular details; that in the latter case, the act of learning consists in apprehending the details as isolated items and then combining them into a whole; that the attention of one is characterized by its intensity of concentration and by the fact that it progresses by means of a series of acts of fixating, while that of another is diffuse and fluctuating, and vacillates between forward and backward movements during the process of establishing its associations; that in one pupil the emphasis in the mechanical aspect of learning is upon the auditory word elements, in another pupil upon the visual or the motor, or any combination of the three; that certain pupils make extensive use of secondary clues such as memorial localizations. Speaking generally, the teacher who proceeds in this investigative fashion ascertains that the whole activity of learning is constituted differently according to the fundamental characteristics of the individual's memory, and that every individual must first learn how best to make use of his own peculiar means to remembering.

Here is a problem in memory training regarding whose solution psychologists are far from being in agreement. In consequence of general psychological considerations and of the results of certain experiments, psychologists have held that pupils should be instructed to employ as many memorial factors as possible, or, in other words, to learn by means of all of the senses and by means of the content or meaning of the material as well. Other authors are of the opinion that it is better for each individual to work with the factors which conform with his own endowment or type,—the auditory

learner with auditory images, etc. An investigation by Bigham[1] seems to support the former view. Bigham determined whether an observer makes more errors in the immediate reproduction of numbers and colors when he retains the impressions by auditory imagery alone, by visual imagery alone, or by both of these means in combination. Numbers and colors were learned by simply seeing them in one case, by simply hearing their names in another case, and in a third case by the two modes of presentation together. His results show that visual memory acting alone retains better than auditory memory alone; and that when the two memories co-operate, the number of errors is considerably less than when either memory operates alone. Thus when the names of ten colors were presented, an average of 7.6 were remembered; when the colors themselves were seen 8.2 were remembered; when they were seen and their names were heard at the same time 9.5 were remembered. This result also seems to be supported by theoretical considerations. Indeed, one may say that the more associative connections a content of consciousness enters into, the more aids are present for its retention and reproduction.

But Bigham's experiment is too crude to furnish any proof; and against the general consideration it may be urged that the number of associative connections is by no means the sole determinant of retention. Retention is rather a matter of stability and strength of associative bonds. In investigations of immediate and permanent retention I have found that unpractised observers retain better when they employ only the sort or sorts of imagery which correspond to their ideational type than when they are asked to make use of all possible sorts of imagery. For example, in the case of the unpractised auditory individual the request that he shall attend also

[1] J. Bigham, Memory, *Psychol. Rev.*, I., 1894, 453–461.

to the visual images of the letters, numbers, syllables and words may produce such a decrease of memorial efficiency that he retains very much fewer data than when he directs his attention only to the auditory imagery with which he is conversant. The explanation of this is to be found in the fact that the unusual direction of his attention to the visual images weakens the association of the auditory images without furnishing any compensatory strengthening of association by means of visual images. This is in accord with our experience that a beginner sometimes requires a ridiculously great number of repetitions (sixty, seventy or more) for the learning of a series of twelve meaningless syllables, while on the following day he may succeed in learning an equally long list of new syllables with one-half or one-third as many repetitions. In such cases, it is always possible to show that the beginner must first discover his learning type, and that in his first few sittings he vacillates between different modes of learning. None but practised observers can learn to make use of means of memorizing with which they are not naturally conversant.

From this it seems to follow that memory exercises for children must at first be adapted to their peculiar mental types, and that children should first acquire an ability to make exclusive use of their connate memorial endowment. Not until they have attained an increased degree of memorial efficiency will it be possible for them to make a transition to the gradual process of rounding out their one-sided memorial endowment.

A second important point in instructing children in their process of learning would consist in teaching them that in learning significant material an understanding of the subject-matter must be made to co-operate with the indispensable mechanical aspect of all memorization, and also in directing

them as to how this co-operation is to be brought about. A complete understanding of the content should constitute the starting-point of all learning,[1] because otherwise it is impossible to avoid the danger that a tedious mechanical memorization of an uncomprehended text may be substituted for a rational acquisition of it, and,—what is psychologically more important,—in that case the valuable memorial aids which inhere in the understanding of the content are not employed to the best advantage in the act of learning. In addition to this, however, the attention of the child must be especially directed to the sensory vehicle by means of which the subject-matter is conveyed to his consciousness. As early as possible the child should be given instruction in rhythm and rhyme, correct pronounciation, the length of words and sentences, and whatever other features correspond to his ideational type. In so doing we may show, at least to the more intelligent child, that the choice of words is not an arbitrary or accidental matter in so far as their purely sensory character is concerned. This marks the first step toward guiding the mechanical factor of memorizing in the proper direction. The second step in the same direction consists in showing him the necessity of vigorous repetition with constant concentration of attention upon the subject-matter and upon the mechanical and sensory elements.

Meanwhile it is exceedingly important that the child should receive a hint as to the difference between aimless, ineffective repetition and that sort of repetition in which attention and memory receive the full benefit of every single reading. This can be done by showing him the differences between the various methods of learning. I have discovered that the whole-procedure is advantageous not only in the laboratory, for teachers of my acquaintance have also submitted it to a

[1] See pages 297ff.

thorough test in their schools. Let the children see how wholly different is their concentration of attention when they learn by means of the whole-method or by one of the mediating methods, and when, in employing the part-method as they ordinarily do, they waste an extravagant number of repetitions on the first few lines of a stanza of poetry and neglect the other lines. My own experience shows me the necessity of using the child himself as an illustration in demonstrating how the various methods differ in their effects upon retention and reproduction; it encourages the child to adopt a particular method in his learning, and it also contributes to his enjoyment of the act of learning. It is scarcely necessary to add that all of these instructions may be given without burdening the child with psychological terminology.

The fundamental characteristics of his attention may also be pointed out to the child. If he is led to see that his attention is slow to adapt itself to its task, this may spur him on to overcome his defect. And the practical precepts which follow from Kraemer's investigation may also be included here, especially those which concern the adjustment and direction of attention upon the results to be attained in the act of learning.[1]

Practical exercises in appropriate memorial work may go hand in hand with theoretical instruction. Let the child first be taught that all memory work should begin with a correct apprehension of the content which is to be remembered, and that the accuracy and care of this initial apprehension, the sensory perception and the motor reproduction of the verbal material as well as the concrete-logical understanding of the material to be remembered are fundamental conditions of memorial acquisition.

The precautions which are to be observed in order to secure a compliance with this rule are different in the mechanical

[1] See pages 293ff.

learning of unrelated data and in significant learning. In mechanical learning,—for instance, in learning words of a foreign language,—the auditory, motor, and visual elements of the words must be apprehended as accurately as possible in purely sensory fashion before the learning begins; and during the first few readings the rapidity of speaking and of learning is slackened to such a degree that an accurate sensory apprehension may become possible. In the learning of significant material, the complete penetration or "soaking in" of the content, in its concrete and logical relations, constitutes the analogous pre-condition of memorial work. The accuracy, rapidity and range of the apprehending attention can be improved by practice; and this improvement contributes indirectly to the work of imprinting upon memory. To what degree one's rapidity in apprehending visual words can be improved by practice may be seen from experiments in tachistoscopic reading. The tachistoscope is essentially a falling screen which may be made to drop with variable rapidity, and to expose a word for an instant at some point in its course. By means of this instrument, one may determine the shortest exposure-time during which words may still be read. If a great many persons are trained in the rapid apprehension of words, it may sometimes be determined that their reading-time is generally reduced by seven-fold to eight-fold, so that most observers ultimately read a word with an exposure-time of three to four one-thousandths of a second. The rapidity of apprehension of content can likewise be increased by practice. But the more rapidly and accurately the visual-auditory impressions and the content or meaning of the material are grasped, the more rapidly does the single reading become effective for memory; while the individual who apprehends inaccurately and slowly devotes more readings to the mere process of completing his apprehension.

Still more important is it to give practical instruction in the concentration of attention for the act of learning itself. A certain education of attention for the act of learning is necessary if memorization is to attain its highest efficiency. Investigation shows that this end can be accomplished by regulating the rapidity of reading and in general by following the precept: Learn slowly and accurately at first, then gradually increase the rapidity of reading and learning. Psychological investigations have furnished us with valuable observations regarding the best means of attaining a uniform and intensive degree of concentration of attention. We frequently make perception and reading more difficult by artificial means in order to obtain a higher degree of concentration. Thus, when nonsense-syllables are being read from a revolving drum,[1] the rotation is sometimes increased to a very rapid rate, and the observer is obliged to read with a maximum concentration of attention or the syllables will disappear from view before he has apprehended them. The attention of the child may be trained in similar fashion, by obliging him to read through a slit which moves at a definite rate of speed across the list of words or other non-coherent memory material. We find, too, that when distractions of attention, such as noises, are introduced into the experiment, these oftentimes give rise to no distracting effect but to an increase in the efficiency of attention and memory. In these cases the distraction is more than compensated by an increased concentration of attention. The presence of his class-mates in the school-room constitutes a natural "distraction" which increases the efficiency of the child's attention; class-learning may, then, be one of the most effective means of attaining a higher degree of attentive concentration upon the part of the pupil. Investigations have recently been undertaken which

[1] *Cf.* p. 164.

aimed to compare the class-work with the isolated, individual work of the child; and in almost every instance, the class-work was found to be superior. These investigations also show that the energy expended in protecting attention from distracting stimuli is greater in class-work than in solo work.[1] The sort of directions which the teacher gives to pupils exerts an influence upon the intensity of attention. The same task is attacked by the pupil in wholly different fashion according as the teacher instructs him to do it slowly and well, to do it rapidly and well, or to do it as rapidly as he can. We have already discussed the form in which instructions for memory work must be expressed. From the nature of these practical instructions for memorial exercises it also follows that the exercises must be done under the control of the teacher, and for the same reason they must be done as class-work. A comparative study of work which is done individually and as class-work shows in general that the more the pupil studies in class, the more efficient does he become in concentrating upon his learning; and, on the other hand, if home-work is done under distracting influences it frequently has a deleterious effect upon the concentration of pupils who are prone to distraction.

As to the arranging of memory exercises, the results of school experiments show that the first hour of the day should be chosen for those exercises in which the formal purpose of memory development is most emphasized, because in the first place, school-children possess the greatest amount of psycho-physical energy during the first and second hours, and they are then still free from the influence of fatigue; and in the second place, their memorial efficiency fluctuates between wide limits at different hours of the day.

[1] *Cf.* the references to A. Mayer, F. Schmidt, and K. Roller, in the Bibliography.

Immediate retention, no less than permanent retention, should receive systematic training in school. If the adult can almost double his immediate retention by practice, we may expect an even greater improvement of this capacity in the child. Dictation and every other form of school activity which appeals to immediate retention may be used as a means for the systematic training of this function. For example, lists of words may be read aloud by the teacher up to the limit of immediate retention, before the real memorization of the list begins.

8. The Actual Memorial Efficiency of School Children Compared with the Results of Experimental Investigations

We have offered certain suggestions for the systematic development of memory in the school-room. If now we consider the memorial efficiency of the child as it actually exists, we find that the investigations of school-children of different ages reveal an unsatisfactory state of affairs. It has already been mentioned that Miss Steffens, working at the instigation of G. E. Müller, was the first to make a detailed investigation of the natural methods of learning employed by school-children. She found that children learn in a much more uneconomical way than adults, and particularly that they learn with an exceedingly injudicious distribution of repetitions. Her experiments also showed that the amount remembered and the compass of immediate retention, as well as the fidelity and accuracy of remembrance are much greater in adults than in school-children of any age, even when purely mechanical learning is concerned. In Pentschew's investigation in the Zurich laboratory it was found that school-children at the age of nine years never succeeded in remembering more than fourteen nonsense-syllables which had been learned in a purely mechanical fashion and as a whole series; it was observed,

too, that they soon become very much fatigued. Adults, however, learned lists which were at least twice as long, without fatigue, although the material did not conform to their usual mode of memorizing; and practised adults were able to memorize twenty-four, thirty-six or even more syllables at a single sitting. In class-experiments conducted by A. Mayer in Würzburg, certain pupils required from eighty to one hundred repetitions for the memorization of ten syllables; two of my most highly practised observers learned this number of syllables with an average of three to four repetitions.

A somewhat similar state of affairs is found in immediate retention. As already described,[1] my own experiments in immediate reproduction showed that children of ten to twelve years retain an average of about four letters, and that children of thirteen to fourteen years retain an average of five to six letters and not quite so many syllables, while our practised adults retain as many as thirteen to fourteen letters and approximately the same number of words. This clearly shows that the memory of school-children is much less efficient than is to be expected. Experiments by German, American and French teachers have shown that the improvement in memory with increase of age is slight. The memory of children seems to improve but little after they have reached the mean school-age. This fact has been confirmed by nearly all investigators, but the differences were not always so slight as Binet and Henri found them to be. Indeed, Bourdon found even a worse state of affairs, so far as increase of memory in children is concerned, than appears from the data which we have quoted. Bourdon tested the memories of one hundred pupils between the ages of eight and twenty in the high schools of Paris. According to his results, memory improves slowly from eight to fourteen years; from fourteen to twenty years

[1] *Cf.* p. 321.

it remains wholly unchanged or improves in scarcely perceptible degree.

How is it possible that the child's memory develops so little during all his years at school, notwithstanding the fact that it is exercised and trained every day and every hour? General psychological considerations and experimental investigations lead one to suppose that the child's memory is much more plastic and impressionable than the over-burdened memory of the adult. The fact that, notwithstanding its possibilities of development, memorial efficiency improves so little during school-age forces one to form an exceedingly unfavorable opinion of school methods of memorization, in so far as their value as formal training is concerned. As a matter of fact the child's learning does not improve his memory; there seems to be but a single factor which contributes to a development of his memory and that is his own increasing age. And this slight improvement in memorial function he does not owe to the school. His learning at school is organized and conducted from a purely material or non-formal point of view; and in consequence of this, his memory is demoralized and becomes a mere matter of accident. Yet in spite of this, it improves somewhat as a result of his natural development.

The serious complaints against the current learning of the schools, which is regulated in accordance with no psychological laws, are based chiefly upon the fact that school-children who have been subjected to formal memory training in our laboratories have frequently shown a ten-fold increase of memorial efficiency; the fidelity of their retention, although not increasing by nearly so much, is likewise essentially improved; and their accuracy of reproduction also increases. The empirical determination of the child's lesser capacity to learn must not, however, be employed simply as a justification for heaping reproaches upon the schools. The chief weakness of these

charges lies in their assumption that the child has, as a matter of fact, a much more plastic and impressionable memory than the adult. This assumption, couched in this general form, is too indefinite; and although a psychologist has recently asserted that, strictly speaking, the memory of the child decreases steadily in impressionability with advancing age, and that the child's whole gain is a gain in concentration of attention, one can readily cite experimental evidence to show that the pupil's capacity to learn increases steadily with his years.[1] Yet the fact remains that notwithstanding all his learning at school he shows but little improvement; and the question arises as to what inference is to be drawn from this circumstance.

My inference is, first of all, that it is absolutely necessary to introduce into the schools a formal training of memory such as we have suggested. According to our experimental investigations, it must be possible to increase the memorial efficiency of school-children by three or four-fold, by giving them systematic instruction based upon sound psychological principles, and by training them in retention as such. Are we, then, to resort to purely formal memory exercises? And are we to drill pupils in the most efficient methods of learning by means of material which is itself valueless? This question I should answer in the negative; or at least I should say that purely formal exercises are to be employed only occasionally and secondarily, as for instance, when it becomes necessary to train an especially inattentive learner by private treatment outside school-hours. Meaningless material with accurately controlled methods of learning would serve well for this purpose. But there are two important reasons for not introducing purely formal memory exercises, a practical and a psy-

[1] J. J. van Biervliet, Esquisse d'une éducation de la mémoire. *Revue de philos.* III., 1903.

chological reason. The practical reason is this: Specific formal mental training cannot be added to the over-loaded curriculum of the public school. There simply is not time for it, because what may justly be demanded for memory may with equal justice be demanded for other mental capacities; and if we introduce formal mental training why not also exercises in apprehension, judgment, speaking, etc.? In short, we would return to the atrocious speech-drill of Pestalozzi, or to the monstrous words of the orthographical training of the Philanthropinists.

As a matter of fact Biervliet has recently arrived at this conclusion, apparently without a knowledge of the failure of the older pedagogy in this direction.[1] But there are also psychological objections. Purely formal memory exercises with meaningless material must necessarily train the child's mechanico-meaningless method of learning; and he would never discover the correct use of the most important factor of memory,—the proper reinforcement by the meaning of the material. This latter procedure can be learned only by means of material which has meaning and value for consciousness. This, however, is not tantamount to saying that valuable formal training of memory and a systematic improvement of methods of learning cannot be combined with the material already contained in the school curriculum. Only to this extent would I be in favor of a formal mental training. The materials which are already prescribed by the curricula of the schools must be learned in such fashion as will contribute as much as possible to a formal training of memory; and the act of learning must be performed in a manner which is psychologically sound. I have already endeavored to offer suggestions as to how this may be done; children must, above all

[1] Thus Biervliet recommends exercises in the pronunciation of such words as lololilalulilo and lalabarakalamana. *Op. cit.* p. 506.

else, be instructed in the proper use of their memorial equipment and in the acquisition of a technique and an economy of learning which is psychologically and practically justified. A complete organization of such exercises can be attained only by a systematic co-operation of psychological observation and pedagogical practice.

Another psychological objection to the demand for formal mental exercises in the schools has recently been advanced; but it does not seem to me to be valid. In an interesting study of memorization Netschajeff[1] has urged the following consideration against this demand. "Experimental psychology has shown . . . . . . that different sorts of memory are to be distinguished from one another. Is it possible for training to exert a beneficent influence upon all of the memorial functions of a given person? For instance, can a composer who endeavors to strengthen his auditory memory by rehearsing various melodies hope that his visual memory will also be improved by this means? Experimental investigations do not justify us in answering this question in the affirmative. We know only that practice in remembering certain impressions strengthens our capacity to remember this one sort of impression alone." Then the author adds that it might sometimes appear "as though the training of a particular sort of memory also strengthens other forms of memory;" it is probable, however, that this is not due to a training of the general memorial function but to the fact that the practised learner has acquired certain "schematic devices," clues, knacks, and a more advantageous general behavior in consequence of which his general learning is now improved. In short, Netschajeff claims that there is no general memorial function, but only a group of special memories; that for this reason no general formal training of memory is possible, but that we can train

[1] A. Netschajeff, *Ueber Memorieren*, Berlin, 1902, 20.

only a certain special memory,—memory for tones, or colors, or names, or numbers, etc. From this he infers that the development of memory at school can proceed only in such fashion that the child acquires "certain rational schematic methods" of memorizing.

In the foregoing, we have demanded two things instead of one, namely: The introduction into our schools not only of general memory exercises, but also of methods of learning which are psychologically sound. In the first place, Netschajeff appears to overlook the fact that even if a general improvement of memory is due solely to the learner's acquisition of a more advantageous procedure in learning, still the school may derive profit from memory exercises because it is a matter of indifference to the teacher whether the general concomitant training of other sorts of memory is due to one cause or to another,—to the presence of a general memorial function which is improved and strengthened by practice, or to an improvement in certain general factors of another sort such as attention, interest in learning, or the practical procedure or behavior of the learner. Even in the formal discipline of a special memory these more general factors which are indirectly advantageous to retention are improved. The student of pedagogy is interested only in determining whether, as a matter of fact, a general training of memory is possible; the psychological basis upon which it rests concerns him only indirectly as a practical man.

Ebert and Meumann have made an experimental investigation of just this very question, as to whether there is such a thing as a general memory training; and their experimental findings were unequivocal and positive. The following experiment was carried through with six observers. First, in a series of preliminary experiments the existing state of the observer's memory was determined, *i.e.*, a cross-section was made

through all of his special memories. They first of all tested immediate retention by determining the compass of retention of numbers, letters, words, nonsense syllables, stanzas of poetry, and selections of prose. Then they tested permanent retention in the genuine learning of nonsense syllables, poetry and prose; and finally a special investigation of visual memory was made. After the chief sorts of memory in unpractised individuals had thus been determined quantitatively, the drill experiments began. Only a single type of memory was trained,—the mechanical memorization of nonsense syllables,—and the training was continued through thirty-six consecutive days. At the end of this period, they again made a cross-section through all of the varieties of memory present in the individual in order to discover whether these other memories had profited from the training. Then they again trained certain of the observers for eighteen, others for thirty-six days, in the mechanical retention of nonsense syllables; and then once more a quantitative determination of the special memories was made.

Now these experiments show that all of the sorts of memories were considerably improved by mere drill in the learning of nonsense syllables. Even a function which is so different from genuine memorization as the immediate retention of non-significant impressions had been considerably strengthened. Purely visual memory had been improved by the learning of nonsense syllables, as had also the learning of abstract prose selections,—a function which is utterly different from the practised function; and the memorizing of poetry had also been improved.[1] This, to be sure, establishes only the fact that there is such a thing as a general memorial training, and that our whole memory is improved when we train it

[1] Ebert und Meumann, *Uebungsphänomene im Bereiche des Gedächtnisses*, Leipzig, 1904.

with any sort of material. It does not, however, determine to what cause this fact is due, whether to an improvement of certain general mental factors such as attention, which may be of indirect advantage in all learning; or to the existence of a general internal relationship among all of the special memories, in virtue of which every training of one memory brings with it a concomitant training of all other memories; or to the existence of a general memorial function. I have been engaged for some time upon additional experiments which aim to settle this question which is so important for psychology.

Coover and Angell[1] have recently investigated this problem anew. In experiments which dealt with related mental functions, they found that the effects of practice may be shown to be transferred from a trained to a non-trained function. For instance, one's discrimination of brightnesses is improved by a training in the discrimination of pitches; and training in certain complex reactions is transferred to other reactions. These authors refer the phenomenon of transfer to an improvement in certain co-operating factors, such as habituation, a more economical adaptation of attention to the stimuli, and an increased concentration or a capacity to ignore distracting influences and accessory circumstances during the act of observing. This seems to me to leave the main problem still unsettled; but so far as pedagogical practice is concerned, Coover and Angell's investigation establishes the existence of a transfer of training,—a result which has a purely practical significance. Winch[2] went a step farther in his investigation of transfer of training in school-

[1] Coover and Angell, General Practice Effect of Special Exercise, *Amer. Jour. of Psychol.*, XVIII., 1907, 328–340.

[2] W. H. Winch, The Transfer of Improvement in Memory in School-Children. *Brit. Jour. of Psychol.*, II., 1908, 284–293.

children. In his first series of experiments,—with girls whose average age was thirteen years,—he showed not only that practice in the learning of poetry transfers to the learning of history, but that the transfer is present in high degree in the majority of pupils. In a second series of experiments, memory for geography was considerably improved by practice in the learning of poetry. Winch's chief result is thus expressed: "Training which is acquired through the memorizing of one sort of subject-matter may be transferred to the memorizing of other sorts of subject-matter whose nature is certainly diverse from the first." In these cases the investigation dealt with the existence of transfer in verbal memorization. And the question arises as to whether "rote memory," or the mechanical remembrance of verbal material, transfers to "substance memory," or the remembrance of significant material. Winch answers this question in the affirmative. Boys and girls, ten to twelve years of age, improved their memory of the essential content of a significant text by mechanically learning verbal materials; not only did practice in mechanical learning improve "substance memory" but the amount of improvement was sometimes greater in the latter (unpractised) case than in the former (practised) case. This investigation proves that the transfer of memory training occurs in children as well as in adults.

The student of pedagogy, however, is primarily interested only in the fact that such a general training of memory is possible. And in consequence of this fact he may make, on behalf of the schools, a renewed demand for memory exercises which shall aim to improve memory itself, and which shall, in that sense, constitute a formal training of memory. Let us point out once more that this does not mean a demand that for purposes of memorial training the schools shall resort to the use of material which is itself valueless,

such as nonsense syllables; it only means a demand that in learning the materials which are now prescribed by the school curriculum memory may, and indeed must, receive a specific training.

We may now finally report a group of experiments which deal with the degree to which memory may be improved by training. There are two points to be taken into consideration here. In the first place, it may be asked where, after all, is the limit of general improvement of capacity. In how far can memory, in general, be improved? Then, in the interests of pedagogy, we may enquire how far is it possible to level down or to eliminate individual peculiarities of memory. Light is thrown upon both of these problems by our investigations of practice. As to improvement of memory, we can only say that it has no limit,—at least, a given memory function may be developed to a maximum degree by practice. For example, the maximum efficiency in the learning of a series of syllables of a given number is reached when the series is learned in a single reading. As a matter of fact, two of my observers very frequently succeeded in learning a twelve-syllable series with three readings, and sometimes even with two readings. I do not doubt that it would have required but a slightly longer continuation of our practice experiments to enable these observers to learn a twelve-syllable series with but a single reading. Now one of these observers, *Ba.*, required forty-nine repetitions for the learning of a series of twelve syllables at the beginning of our course of training; and the other, *F.*, required fourteen repetitions. The complete effect of training upon the memory of the adult can best be understood from the following summary. The numbers of repetitions required for learning ten nonsense syllables were as follows (see next page):

Observers	*Repetitions required at the beginning of the experiments*	*Repetitions required at the end of the experiments*
	(For the learning of ten nonsense syllables)	
Ba.	28	3
F.	23	2
Br.	25	4
M.	31	4
	(For the learning of sixteen nonsense syllables)	
Ba.	31	5
F.	19	5
Br.	23	8
M.	34	3

It is also characteristic that the progress of memorial training is not so evident in the learning of significant material as in purely mechanical learning. In the case of significant material the mechanization of learning is not always present in equal degree; and it is the mechanization of learning which seems to be the factor which profits most from continued practice. The following data were obtained in the learning of prose:

	Repetitions required without practice	*Repetitions required with practice*
Ba.	36	14
Br.	26	11
F.	17	5
S.	38	10

On the other hand, the training of visual memory which certain of our observers acquired from the learning of nonsense syllables produced an extraordinary degree of improvement

in the memorizing of visual impressions. The visual impressions, twelve in number, were all geometrical forms which were varied in regular order during the course of the investigation. The results of these experiments were as follows:

Observers	*Repetitions before training*	*Repetitions after training*
Ba.	25	7
Br.	26	6
F.	24	7
S.	43	6

There can be no doubt that so great an amount of transferred training cannot be explained from a mere acquisition of mechanical devices which aid in memorizing; we are compelled to assume that a concomitant training of related functions of memory took place.

It is especially to be noted that three older observers took part in all of these experiments, one of whom was thirty-six, another forty, and the third fifty-four years of age. And although the effect of practice was very considerable in the case of these three observers, still it did not even approximate the amount which appears in the results of the students. At about the age of forty years then, it seems probable that a retrogression of memory occurs even under conditions of maximum practice. If we examine our whole group of experiments, which included observers ranging from seven to fifty-four years of age, in order to determine at what age the greatest memory efficiency can be attained by an approximately equal amount of practice, we shall find that the period lying between twenty and twenty-five years is the optimal age of memorial efficiency. In any discussion of the possibility of eliminating individual differences of memory, and of making all memories conform to a common type we must

distinguish between real defects of memory and such cases of one-sidedness of ideational type as are due solely to a predominance of certain sense-elements in an individual's stock of imagery. The case of Dodge may be cited to illustrate a defect in auditory imagery. When auditory imagery and the memory of tones are lacking to such a degree as in Dodge's case, it seems probable that practice, no matter how long-continued, would not produce any marked result. So great a degree of lack of development of a particular sort of imagery occurs but seldom however. In all of the individuals whom I have investigated the sensory qualities of all modalities were to some degree represented by imagery, although a marked predominance of some particular sense-modality could be observed in certain cases. In all such cases, it seems to be possible to make the equipment symmetrical and well-rounded by a process of training.

It is natural, however, to institute a comparison between the brilliant success which has attended the systematic training of memory in laboratory experiments and the dismal failure of the schools in the training of this function. It might be supposed that the slight improvement in the formal function of memory during the school-years could not be explained solely from the fact that children learn by means of unpractical and imperfect methods, because experience teaches us that a bodily or mental function improves even when its training has not been done in accordance with the most appropriate methods. This consideration indicates that there may be a deeper reason for all improvement which results from training. I have repeatedly observed in my laboratory experiments that every improvement in mental or bodily skill which results from practice is, in the last analysis, a phenomenon of will. We profit from continued practice only in proportion as we incite the will to progress and arouse an

intention to improve. The mere repetition of an act, even though it be repeated daily, is by no means sufficient to bring about an improvement in the execution of the act; one may even fall into a mechanical routine during which no improvement appears even though the activity be repeated hundreds of times.

So long as the observer in a psychological experiment does not suspect that he is able to improve in a mental capacity, improvement is sure to be lacking; but so soon as we arouse his intention to perfect the activity which is being practised the improvement itself ensues. This statement is confirmed by the result of an interesting experimental observation. Radossawljewitsch[1] began a series of experiments in my laboratory with an observer who had not yet fully mastered the German language. He had failed to understand the object to be attained in the learning of the nonsense syllables; and the repetitions continued to be non-effective until he understood his instructions. The will to memorize was now aroused; and now, for the first time, the repetitions became effective.

This phenomenon, which was thus revealed to me by incidental observations in the laboratory has been made the sub-

[1] Radossawljewitsch describes the incident as follows: "*G.* volunteered to serve as an observer in my investigation. Before the experiments began I showed him the apparatus and demonstrated the method. At that time he knew but little German, and did not fully understand my description; but he sat down before the apparatus and began to read aloud a series of eight syllables. He read it twenty, thirty, forty, even forty-six times without announcing to me that he had committed it to memory, as he had been requested to do in my instructions. I had begun to fear that the experiment would not be a success, and after the forty-sixth repetition I stopped the apparatus and asked him whether he could recite the series. 'What! Am I to learn the series by heart?' was his response. He still required six more repetitions; but he reached his goal without difficulty." *Cf.* Radossawljewitsch, *Op. cit.*, 127.

ject of a special investigation by Judd.[1] Judd arranged an experiment in which a number of observers, whose hands were obscured from view behind a screen, drew oblique lines from a copy which lay before them. They did not see their hands, nor did they know with what degree of accuracy they accomplished their task; and in consequence, their practice was non-effective. From Judd's statements it seems to me to follow that the will to form a habit or to improve by practice demands, above all else, the controlling influence of a consciousness of improvement, and indeed for a two-fold reason,—*1.* in order to have a standard by reference to which the individual may determine the amount of his improvement; and *2.* in order to guide the practice qualitatively in the right direction. Judd shows that if this control is lacking, a falsely directed and inappropriate habit may be formed which is difficult subsequently to eradicate.

Thus an intellectual and a volitional factor co-operate when we improve by practice. Intellect furnishes the standard, shows the quality of the defect which is to be overcome, and prescribes the direction in which improvement must take place. These constitute the content of the idea of success or improvement which directs the whole process. The volitional factor appears to consist in the energy, the intensity and the persistence with which this idea of improvement is fixated and with which practice is repeated under its influence.

All of this information is of prime importance for pedagogy. It shows us that *1.* the arousal of the will to improve is of fundamental significance in all mental and bodily improvement, and *2.* that this will cannot be a mere "empty"

[1] C. H. Judd, Practice without Knowledge of Results, *Psychol. Rev. Mon. Supp.*, VII., 1905, 185–198; see also C. H. Judd, Practice and its Effects in the Perception of Illusions, *Psychol. Rev.*, IX., 1902, 27–39.

volition; it must be gauged by fixed standards and it must be under the constant control of the end. In our every-day affairs we have similar experiences. Whoever has learned an athletic game is familiar with the phenomenon that he soon reaches a certain stage of skill or efficiency where his progress seems to cease, but that his skill and efficiency both improve again when he compares himself with others who have made greater progress in the same game. By this means the will to improve is aroused; and now the efficiency itself improves. This constitutes the basis for the significance of standards in all human efficiency and development; the pace-maker improves the efficiency of the bicyclist or at least holds it up to its maximum. A similar phenomenon is observed throughout the whole mental domain. A single original genius who sets up new standards for the art and the science of his generation and establishes a higher "record" of ability and scholarship can raise the efficiency of hundreds of lesser geniuses of his generation. The art of a country or of a people is oftentimes found to be raised to a higher level by coming into contact with people of superior culture or of superior artistic achievement. The higher standard, with which the artist compares himself, itself gives rise to a higher art. This may perhaps explain why the art of the miniature painters, the frescoes of the Byzantine and Roman periods, the grotesque smile of Gothic sculpture, as well as the jejune poetry of an Opitz should have met with admiration in their generation; neither the artist nor the layman of that time knew the possibilities of art.

Returning from this digression to the development of memory in school-children, we now discover the real reason why the development is so slight in spite of their daily exercises in learning. The will of the child is not directed toward an increase of formal memorial efficiency itself, but is directed in

one-sided fashion toward an acquisition of certain definite data. This explains why, notwithstanding his daily training in memory and in immediate reproduction, the child's progress in these two functions appears to be conditioned solely by his increase in age, and is entirely disproportionate to the actual use which is meanwhile being made of his memory. In our laboratory experiments, on the other hand, the intention to improve one's memory is awakened from the first moment onward, the real experiments having been prefaced by preliminary exercises in which the observer practised until maximum efficiency was attained. Thus it comes about that even school-children, when they take part in laboratory experiments, soon show a considerable improvement in memorial ability. And this again indicates the necessity of school exercises in learning, in which besides the material end,—the acquisition of data,—the formal proficiency of memory itself shall be sought.

APPENDIX I

THE CONSTRUCTION OF SERIES OF NONSENSE SYLLABLES

The method of constructing series of nonsense-syllables was systematized by Müller and Schumann. They had found that when syllables are arranged in random order, as in the experiments of Ebbinghaus, the different series present unequal degrees of difficulty. And they stated that this lack of uniformity is due to the fact that a series of syllables is more easily memorized: "*1.* When it contains alliterations, that is, when adjacent syllables begin with the same consonant; *2.* when consecutive syllables rhyme; *3.* when consecutive syllables or the initial syllables of consecutive rhythmic groups contain the same vowel or diphthong; *4.* when the initial consonant of the first syllable and the final consonant of the second syllable of a rhythmic group of two syllables are identical, or when the final consonant of a syllable and the initial consonant of the succeeding syllable are identical; *5.* when two or more syllables make a word (Berlin) or a phrase (send us). On the other hand, learning is hindered by a frequent recurrence of diphthongs or of consonants which are difficult to pronounce, such as sch and z. When two syllables belonging to the same series are similar,—for instance, if two of their letters are identical,—the learning of the series may be rendered more easy, although, if the similarity causes confusion, the series is rendered more difficult."

"In order to make the various series of syllables as nearly uniform and as comparable with one another as possible" Müller and Schumann employed only 'normal series' of twelve syllables, which had been constructed in accordance

with a special method. "Each of the seventeen initial consonants, b, d, f, g, h, j, k, l, m, n, p, r, s, t, w, z, sch, was written upon a small card. These cards were shuffled and put into a box where they could not be seen by the experimenter. Cards containing the vowels and diphthongs, a, e, i, o, u, ae, oe, ue, au, ei, eu, were put into a second box; and cards containing the twelve final consonants, f, k, l, m, n, p, r, s, t, z, sch, were put into a third box. In the constructing of a 'normal series,' three cards bearing an initial consonant, a vowel, and a final consonant were taken at random from the three boxes, and the letters upon these three cards were combined to form the first syllable. The letters upon the cards next selected made up the second syllable, etc. Letters which had been used for the making of a syllable were, of course, not returned to their respective boxes until the construction of that series had been completed. By this means we fulfilled the condition that all of the initial and final consonants of a series should be different. One of the vowels or diphthongs had to be used twice in each series since we had only eleven of these letters at our disposal. But the two syllables which contained the same vowel were always separated from each other by at least two other syllables. Soon after the beginning of our investigation we made a distinction between *aa* and *a*, long *a* and short *a*, in order to increase the number of our vowels and diphthongs to twelve.

"This procedure in the constructing of our syllables enabled us to prevent the recurrence of alliteration, rhyme, and assonance as well as to obviate the frequent repetition, within any series, of diphthongs and of consonants which were difficult to pronounce. But we had still to arrange for the exclusion of the conditions which we mentioned under 4 and 5. This was accomplished in the following way: In adding any new syllable to those that had already been constructed, the

experimenter always took the precaution to observe whether either of these objectionable features was being introduced. If it was, the new syllable was inserted at the next appropriate place which could be found for it,—usually at a place nearer the end of the series; only when this was not possible was it given a place nearer the beginning.

At the outset Müller and Schumann entered the syllables in a 'syllable-book' where they were arranged in alphabetical order, in order to check off those syllables which had already been employed. It is essential that one avoid a second use of the same syllable, at least within the interval of time during which they might seem familiar to the learner. They subsequently adopted the plan of recording the syllables in a table instead of in the book, a procedure which made it more easy to check them off. The table contained sixteen vertical columns for the sixteen initial consonants which may be employed and twelve horizontal rows for the vowels and diphthongs.

"When a syllable had been constructed in the manner described by withdrawing an initial consonant, a vowel or diphthong and a final consonant from the boxes, if the syllable was such as could be used, its final consonant was entered in that square of the table which fell in the horizontal row corresponding to the initial consonants of the syllables and in the vertical column corresponding to the vowels or diphthongs of the syllables. And at the same time we added to the tabular record the serial number of the day on which the syllable was to be used. In deciding whether or not any syllable might be presented at any given time, the experimenter need only glance at the column where its final consonant was entered to assure himself as to whether and on what day it had already been presented. If it had been employed within the last ten days, another syllable was chosen." Certain syllables were excluded because they seemed to be particularly difficult to

pronounce, for instance, zaesch, zaech, zoesch, schaach, schaech, schaesch, schisch, etc. The result was that a total of 2210 syllables could be used. Müller and Schumann also lay especial emphasis upon the fact that the composition of the series of syllables is wholly withdrawn from the control of the experimenter; that is, it becomes a wholly impersonal and automatic matter.

APPENDIX II

THE MEANING OF ECONOMY OF TIME AND ENERGY IN LEARNING

The meaning of economy and technique of learning is not so simple as might be supposed; and one finds it difficult to clear up their meanings for the following reasons: These terms are usually employed to mean the saving of time and energy which results from the use of a particular method of learning for the attainment of a particular goal or a particular result as compared with the use of another method. The saving which is effected by employing any one method is always measured in relation to other methods, and always in relation to some particular memorial effect or goal of learning.

We must first explain what is meant by saving time and energy, and what is the relation between the two; and then we shall describe the different memorial effects or goals of learning which one may attain or attempt to attain in relative independence of one another. For instance, if it should be found that one method has the effect of leading rapidly to a first recitation from memory but does not have the effect of securing permanent retention, while another method leads less rapidly to a first errorless recitation but secures a more permanent retention, the former method appears to be more

economical for the attainment of a first errorless recitation but uneconomical in so far as permanent retention is concerned. It is evident then that one can determine whether a given method is economical or uneconomical only by determining how much time and energy are expended in attaining a particular memorial effect, and then comparing this measurement with measurements made from other methods which seek to attain the same result by other means.

For this reason no determination of the economy of a method can ever possess universal validity; one can do no more than reach a decision which holds for the momentary purpose which the learner has in view. Certain measurements of economy of time and energy which have been made by G. E. Müller and his students (Steffens, Ephrussi) are to be evaluated in the light of this fact.

Since economy of learning depends upon the purpose or result which is momentarily desired, it is especially important to have a clear understanding of the extraordinary variety of memorial effects which may be attained by means of observational noting, or learning in the narrower sense. Certain chief varieties of memorial effect which come in for consideration here must be differentiated: *1.* From the point of view of the interval which elapses between acquisition and reproduction we must distinguish between immediate retention, transitory retention and permanent retention.[1] *2.* From the point of view of material effect we must distinguish between completeness and fidelity of remembering, and the retention of different sorts of materials,—such as sensations, spatial and temporal relations, objects, processes, meaningless and meaningful materials, poetry, prose, etc. *3.* From the point of view of formal memorial effect we must distinguish between the acquisition of elements and the formation of associations

[1] See pp. 34ff.

between elements,—for instance, associations between pairs or between groups of elements, uniform associations of all the members of the series, analytical and synthetical retention,—types of retention which are illustrated when the learner knows in advance that he will be tested by means of the *Treffermethode* or by the *Ersparnismethode*,—together with purely anterogressive and purely retrogressive associations, and uniformly secure associations of all the elements of a group of materials with one another; and finally the amount of material must also be taken into consideration. *4.* From the point of view of reproduction we must distinguish between rapidity, certainty, fidelity, and completeness of reproduction.

The determination of the economy of a method of learning may possibly be brought into relation with each of these partial points of view. Any procedure in learning may be more economical than any other from each partial point of view.

When we consider the manifold variety of memorial effects, and when we further take into consideration the fact that each of these memorial effects may be the specific purpose for which an act of learning is undertaken, we see how recklessly decisions regarding economy of time and energy have oftentimes been reached in the school of G. E. Müller. Both Miss Steffens and Miss Ephrussi fail to appreciate that such decisions must be purely relative matters; it is wholly impossible to reach any general conclusion regarding the economy of a method by an exclusive use of the *Treffermethode* which has been so extensively employed by Müller's students. The determination of the number of correct associates decides nothing excepting the general question as to whether or not such a procedure is useful for the attainment of the wholly special effect of establishing pairs of associations, and the special question as to what is their degree of stability.

In addition to these variations which are due to variations in the purpose of our act of learning, differences in economy of time and energy must also be taken into consideration; and the question arises as to how economy of time and of energy can be measured. Several difficulties are involved here.

One might be tempted to suppose that economy of time is distinct from economy of energy because one speaks of an economy of time when one refers to a saving in the amount of time which is expended upon an act of learning, and one speaks of an economy of energy in cases where a saving of energy is effected. Nor can there be any question that one can always measure the saving of time readily and unequivocally from a comparison of learning-times. It is more difficult to measure one's saving of energy, and to make clear its relation to one's saving of time. The gain in time may represent a saving in energy because the procedure which leads to the goal in the shortest time is also most economical of energy, provided that equal demands were made upon the learner's energy, per unit of time, by each of the procedures. But on the other hand, the saving of time may be effected at the cost of an increased expenditure of energy; the intensity of the learner's work may now be so great that a greater amount of energy is expended than would be demanded by another procedure where the learner works longer but less intensively.

The fact that one procedure requires a greater expenditure of time than another for the attainment of an equal memorial result gives rise to a similar duality of relationship; the increased expenditure of time may entail a saving of energy or a loss of energy. When one procedure demands more time than another for the attainment of the same goal, the increased expenditure of time and the increased duration of the learner's work may give rise to a mode of working which is of such slight intensity and which entails such a slight expenditure

of energy that the total expenditure of energy is less during the slower procedure than during the faster procedure. But when the slower procedure involves a greater intensity of work it demands, of course, a greater expenditure of energy.

In the economy of energy, however, we are concerned not only with the intensity of work as such but also with the advent of fatigue, because we always endeavor to give rise to as little fatigue as possible. If now the amount of fatigue may be regarded as an index of the amount of time and of the intensity of work devoted to the task, then the amount of fatigue may be regarded as a measure of the amount of energy expended. Unfortunately this is not the case; the phenomenon of fatigue complicates still further the problem of determining economy of energy because the degree of fatigue present in an individual varies not with the absolute amount of his work but with the ratio between demand and supply of certain materials in his organism. This relation may be subject, at different times in the same individual, to the influence of wholly different causes than time and intensity of work,—for instance, emotional condition, especially prevailing unpleasantness, previous fatigue, and the like.

The amount of fatigue which is present after an act of learning need not therefore be a simple index of the time and the intensity of the work expended, but it may be a product of secondary causes. Hence if we are to be able to measure the amount of energy which is devoted to an act of learning we must discover a direct means of measuring intensity of work. This measure may perhaps be found in the different number of repetitions employed by the learner in acts of learning which are of equal length. If he devotes now more, now fewer repetitions to the attainment of a given memorial effect, learning-time and amount of material being constant, then in the former case he must have worked more intensively

and he must have devoted more energy to the task. That the increased number of repetitions is nothing more than a merely temporal factor is more apparent than real, for every increase in the number of repetitions in a given unit of time means that an increased amount of energy is expended. Repetition is, in the nature of the case, a temporal factor; it means a reduplication of mental work,—that is, an increased expenditure of energy. This is due to the fact that an increase in the number of repetitions necessitates a corresponding increase in the activity of speaking, including its motor, sensory and intellectual components. Hence one may say that so long as one cannot directly measure intensity of psycho-physical work, the measure of economy of energy is to be found in the increased number of repetitions and in the degree of fatigue which they produce. The latter is the less reliable of these two criteria because fatigue not only depends upon the amount of work which is necessitated by the method of learning itself but is also influenced by numerous contributing causes which may exist independently and vary independently of the particular method of learning.

Our discussion may be summarized in the statement that that method of learning is most economical which secures a particular memorial effect or attains a particular memorial purpose in the shortest time, with the least number of repetitions and with the minimum degree of fatigue; and this method may be regarded as the most economical only with reference to this memorial effect and this memorial purpose. Of these three determinations, the learning-time measures the economy of time; while the economy of energy is measured by the number of repetitions and, in less precise form, by the amount of fatigue. No other accurate means of measurement is at our disposal. It may be that the measurement of attention,—especially the measurement of the inhibiting effect of

attention,—will some day furnish us with a direct means of measuring intensity of work. In his psycho-dynamics, Lehmann attempts to take the intensity of work into account in measuring the economy of working. But his discussion is not based upon empirical findings, and we can not here discuss these purely hypothetical considerations. The reader is referred to a recent criticism of Lehmann's position.[1]

APPENDIX III

ADDENDA FROM THE MOST RECENT LITERATURE

In an investigation of the memory of mental defectives Gregor[2] distinguishes between a "normal" and a "successive" type of learner. In the act of memorizing a series of nonsense syllables, the former learns the initial and the final syllables of the series before the middle region of the series is acquired; the latter learns the initial syllable of the series first, and then progresses through the series mastering each successive syllable in consecutive order. I have never found that the latter represents a constant type of learner, although I have sometimes observed that certain learners vary between the two procedures. Hellmut Müller[3] reports that his mental defectives almost invariably proceeded in the "normal" fashion in the learning of nonsense syllables. This author also found that the part-procedure was the more advantageous method of learning in the case of mental defectives,—a lesser resistance

[1] H. Müller, Zur Oekonomie des Lernens bei geistesschwachen Personen, Sommer's *Klinik f. psych. u. nerv. Krankheiten*, VI., 1911, 121–157; see 135 and elsewhere.

[2] M. Gregor, Beiträge zur Psychopathologie des Gedächtnisses. *Monatsschr. f. Psychiat. u. Neurol.*, XXV., 1909, 218–255; 339–386.

[3] H. Müller, *Loc. cit.*

to fatigue apparently being an essential characteristic of their learning.

G. E. Müller[1] has remarked that "there is a tendency to estimate the value of investigations of the economy of learning in terms of the applicability of their results to the affairs of practical life, and especially to the affairs of the school-room." And he adds that "this is a very narrow point of view"; investigations of this sort are, in the opinion of Professor Müller, significant for psychologists chiefly on account of their heuristic value. I know of no psychologist or educator who has evaluated these investigations from a purely practical point of view; and both the form and the content of this random polemic seem to be wholly unwarranted. Professor Müller appears to have confused two radically different issues here. That the pedagogical and practical significance of investigations of the economy of learning should be emphasized in a treatise which is written for a pedagogical purpose is one matter; that the practical point of view should be made the sole criterion in estimating the general psychological value of such investigations is a wholly different matter. When a critic fails to appreciate the fact that the standards by which a book is to be judged depend upon the purpose for which the book was written, it is the critic, not the author, who lays himself open to the charge of "lack of breadth." I have refrained from discussing certain details of Professor Müller's monograph for the reason that they do not seem to me to be of service in pedagogy; and many of his polemical criticisms have not been considered in this third edition because I can not accept the views regarding "precision" in psychological experimentation upon which his criticisms are based.

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[1] G. E. Müller, *Zur Analyse der Gedächtnistätigkeit und des Vorstellungsverlaufs*, (Zeitschr. f. Psychol., Ergänzungsband V.) Leipzig, 1911, I., 402.

I shall illustrate these views by a single example from which the reader may judge how this polemic is, in my opinion, to be regarded.

In Dr. M. K. Smith's investigation of the most advantageous rhythm, to which frequent reference has been made in the foregoing pages, the act of learning under the influence of each particular rhythm was in each instance continued for four days, after having been preceded by preliminary experiments for a period of five days. Professor Müller finds that this investigation was "inexact," "not only because the number of experiments was not sufficiently great but chiefly because the influence of practice was not sufficiently taken into account." This is a characteristically Müllerian criticism. There was an absence of "great numbers of experiments" which according to Professor Müller's idea of precision constitutes the salvation of all experimental psychology. Every psychologist, however, who possesses a modicum of experience in experimentation must grant that with increasing practice the differences in the effects of the different rhythms upon the act of learning become less and less, and with maximum practice they wholly disappear. And everyone who does not cherish Professor Müller's idea of precision knows that these differences are most clearly present with moderate degrees of practice. During the progress of Dr. Smith's experiments I investigated the influence of different forms of rhyme upon the act of learning. The results of all of my observers showed that the different effect of different sorts of rhyme upon the act of learning came to light only during the initial stage of practice; after a certain amount of practice every observer obtained the same learning-effect from each of the sorts of rhyme which we employed,—*i.e.*, practice had eliminated the differences. Over and above this, Dr. Smith found confirmation in the experimental result that our most highly practised

learners found no difference between the effects of trochaic and iambic rhythms. In my own case, no difference in effect of learning with trochaic and iambic rhythms is found because practice has eliminated any differences which may have been present at the outset; even the trisyllabic rhythms produce no noticeable difference in the effect of learning. Hence the point at issue is not so much a "lack of precision" on the part of Dr. Smith as it is a tendency on the part of Professor Müller to judge "in accordance with schema F."

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